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TULANE STUDIES IN GEOLOGY AND PALEONTOLOGY

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CENOZOIC MURICIDAE OF THE WESTERN ATLANTIC REGION PART IX - *PTERYNOTUS*, *POIRIERIA*, *ASPELLA*, *DERMOMUREX*, *CALOTROPHON*, *ACANTHOLABIA*, AND *ATTILIOSA*; ADDITIONS AND CORRECTIONS

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I. ABSTRACT

A total of 124 names have been applied to western Atlantic species referred herein to the muricid genera *Pterynotus, Poirieria, Aspella, Dermomurex, Calotrophon, Acantholabia* and *Attiliosa.* Of these, 97 are valid and are treated systematically; an additional two are cited as "species." These include the following numbers of taxa: *Pterynotus* – 24; *Poirieria* – 35; *Aspella* – 4; *Dermomurex* – 25; *Calotrophon* – 6; *Acantholabia* – 2; *Attiliosa* – 3. There are 43 species in the Recent fauna, but only 29 are confined to the Recent, the remainder are both living and fossil. Of the 97 valid taxa, 12 are new species and are named herein. These are: *Pterynotus (Pterynotus) praepatagiatus,* from the Chipola Formation; *Poirieria (Panamurex) gibsonsmithi,* from the Cantaure Formation and *Poirieria (Panamurex) improcerus,* from the Cantaure and Caujarao formations; *Poirieria (Panamurex) rutschi,* from the Punta Gavilán Formation; *Dermomurex (Dermomurex) sarkini,* from the Moín Formation; *Dermomurex (Takia) portelli,* from the Suwannee Limestone and River Bend Formation; *Calotrophon venezuelanus,* from the Mare Formation; *Poirieria (Paziella) petuchi, Poirieria (Panamurex) eugeniae, Dermomurex (Dermomurex) worsfoldi, Dermomurex (Dermomurex) sarasuae* and *Dermomurex (Dermomurex) binghamae,* all from the Recent.

II. INTRODUCTION

This study concludes the revision of the Cenozoic Muricinae of the western Atlantic begun in Part VIII (Vokes, 1990). It includes material originally published in parts V (Vokes, 1970), VI (Vokes, 1975) and VII (Vokes, 1976b), as well as additional papers appearing since each of the respective parts were published (principally Vokes, 1989b). As with the preceding portion of this series (Part VIII: Vokes, 1990) this is an attempt to bring together all of the species of these genera with the most up to date information on their stratigraphic occurrences.

However, there is a great difference in the amount of new information for these species in contrast to those covered in Part VIII. Only 500 new fossil localities have been added since 1970 and of this number only 325 represent macrofossil collections from the Western Hemisphere (a large number are purely microfossil collections, and many are macrofossil localities in Australia, New Zealand and France). Of these 325 localities almost half (152) are in the Dominican Republic, representing the major thrust of our work in the period since 1976.

Likewise, the changes in stratigraphic

correlation essentially begin in 1972 with Akers' important paper, so that for species treated after that date, the stratigraphic information originally cited generally does not require correction.

Therefore, this revision will consist mainly of new or recently described taxa, together with certain minor changes in taxonomy and stratigraphic data. For an overview of the current status of stratigraphic correlation the reader is referred to that portion in Part VIII (Vokes, 1990, pp. 2-5). Since publication of Part VIII there has been only one significant addition to the stratigraphy of the western Atlantic and that is the naming of strata in the vicinity of Sarasota, Florida, which formerly had been called the "Pinecrest Beds" or the "Pinecrest Formation" by various authors for the last 25 years.

This paleontologically important unit has been named formally the Fruitville Formation (Waldrop and Wilson, 1990). As pointed out by Scott (1990, p. [2]), this is yet another biostratigraphic unit and is just as unacceptable under the terms of the *Code of Stratigraphic Nomenclature* as all that have preceded it (Caloosahatchee, Pinecrest, Tamiami, Buckingham, Bermont, *et al.*). But, given the nature of southern Florida geology, where outcrops essentially are non-existent and lateral correlation is impossible without the included fossils being considered as a part of the lithology of the formation, I will accept this name in the spirit of improved communication as is done for all of the other names currently in use in southern Florida.

Although the age of the beds at Sarasota has been assumed to be Middle Pliocene since Akers' (1974) report, Jones *et al.* (1991) now have provided a definitive study on the age of the entire section exposed at the APAC pit, utilizing an array of dating methods, including macro- and micro- invertebrate and vertebrate remains, paleomagnatism, and strontium isotope chronostratigraphy. It is their conclusion that the lowermost strata (Unit 11 of Petuch, 1982a, *et seq.*) may be as old as Early Pliocene and the main mollusk-bearing beds (Units 5-10) are Middle Pliocene, as previously considered, representing a single marine transgressive event. The so-called "black layer" (Unit 4) represents the regressive stage of non-marine deposition and is followed by deposition of younger beds (Units 1-3), which are correlative with the Plio-Pleistocene Caloosahatchee Formation.

These authors did not record the presence of any Bermont Formation equivalent at the APAC quarry but, as Waldrop and Wilson (1990, p.[29]) note, the presence of *Caloosarca aequalitas* (Tucker and Wilson) indicates beds of this age are present at least in portions of the pit. This is further corroborated by the description of *Murex violetae* Petuch (1991, p. 24, pl. 4, fig. 5), which is a synonym of the Bermont species *Murex anniae* Smith (i.e, *Haustellum anniae,* see Vokes, 1990, p. 21), and *Muricanthus trippae* Petuch (1991, p. 26, pl. 4, figs. 3, 4), which is a synomym of *Hexaplex fulvescens* (Sowerby), otherwise confined to post-Caloosahatchee formations (see Vokes, 1990, p. 79). (It is also possible that either or both of these species are based upon mislocated specimens; as noted by Vokes, 1990, p. 79, large numbers of Pleistocene *H. fulvescens* have been collected at Largo, Pinellas County, some 50 miles north of the Sarasota locality.)

III. ACKNOWLEDGMENTS

As with Part VIII, to thank all of the people who have assisted in this study, I would have to thank everyone I know. Therefore, as before, I would like to begin by expressing my gratitude to all of my colleagues, professional and amateur, who, through the years, have provided information, specimens, and hospitality in their homes and museums. But for the preparation of this paper, I do want to add a special note of thanks to certain individuals. In particular, David T. Dockery, III, Mississippi Bureau of Geology, generously shared material he collected both in the U.S. Coastal Plain and in the Tertiary of France, and Liz Nesbitt and David R. Lindberg loaned me all of the Caribbean fossil muricid material in the collections of the Museum of Paleontology, University of California, Berkeley. Eliezar de C. Rios, Museu Oceanográfico, Rio Grande do Sul, Brazil, loaned many Brazilian specimens for study and illustration. Hortensia Sarasua, Academia de Ciencias de Cuba, provided a most useful collection of muricids taken from the sands dredged to make the harbor at Marianao, La Habana,

Cuba. The single largest addition of material was the loan of the Venezuelan fossil material collected over a period of years by Mr. and Mrs. Jack Gibson Smith, formerly of Caracas, now of Surrey, England. This collection is deposited at the Naturhistorisches Museum, Basel, Switzerland, and was made available through the kindness of the Gibson Smith's and Peter Jung.

A number of friends have loaned (or given) material, both fossil and Recent, to be figured or studied for this work, as well as valuable information on occurrences. They include: Richard E. Petit, North Myrtle Beach, South Carolina; Susan B. Stephens, Sanibel, Florida; Gary W. Schmelz, Naples, Florida; Harry G. Lee, Jacksonville, Florida; Emilio F. Garcia, Lafayette, Louisiana; Roland Houart, Ezemaal, Belgium; James Allen, Alexandria, Louisiana; and Christopher L. Garvie, Houston, Texas. In particular I am grateful to Kevan and Linda Sunderland, Sunrise, Florida, Eugenia I. Wright, Phoenix, Arizona, and Pat Bingham, West Palm Beach, Florida, who provided several type or figured specimens.

Colleagues at many institutions were most helpful in providing information and lending specimens, including: Alfredo Figueiras, Universidad de Republica de Uruguay, Montevideo; Antonio Carlos S. Fernandes, Museu Nacional, Rio de Janeiro, Brazil; Roger W. Portell, Florida Museum of Natural History, Gainesville; Thomas J. Rossbach, University of North Carolina, Chapel Hill; and Andrew K. Rindsberg, Geological Survey of Alabama, Tuscaloosa. The members of the staff of the U. S. National Museum (Thomas R. Waller and Warren Blow, Paleobiology; M. G. Harasewych and Raye N. Germon, Recent Mollusca), the Academy of Natural Sciences of Philadelphia (George M. Davis, David G. Robinson, Andria Garback, and David S. Wiedner), Museum of Comparative Zoology, Harvard University (Silvard P. Kool and Felicita d'Escrivan), San Diego Museum of Natural History (the late George E. Radwin, Anthony D'Attilio, and Regina Wetzer), Carnegie Museum of Natural History, Pittsburgh (Albert Kollar), and the Muséum National d'Histoire Naturelle, Paris (Philippe Bouchet and J.P. Pointier) all assisted in every way possible.

Once again Hubert C. Skinner took on the formidable task of editing the manuscript (however, I still hold him blameless for any errors that have crept through). Zuzana Hruska of the Tulane University Coordinated Instrumentation Facility provided the SEM photomicrographs. And, finally, my deepest thanks go to my husband Harold E. Vokes, field assistant, photographer, curatorial aid, and sympathetic listener.

ABBREVIATIONS FOR REPOSITORY INSTITUTIONS

AMNH – American Museum of Natural History, New York, New York, USA
ANSP – Academy of Natural Sciences, Philadelphia, Pennsylvania, USA
BMNH – British Museum (Natural History), London, England
CM – Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, USA
DMNH – Delaware Museum of Natural History, Wilmington, Delaware, USA
FSBC – Florida Department of Natural Resources, St. Petersburg, Florida, USA
GSA – Geological Survey of Alabama, Tuscaloosa, Alabama, USA
LACM – Los Angeles County Museum of Natural History, Los Angeles, California, USA
MCZ – Museum of Comparative Zoology, Harvard University, Cambridge, Massachussets, USA
MHNG – Muséum d'Histoire Naturelle, Geneva, Switzerland
MNHN – Muséum National d'Histoire Naturelle, Paris, France
MNRJ – Museu Nacional de Rio de Janeiro, Brazil
MORG – Museu Oceanográfico, Rio Grande do Sul, Brazil
NMB – Naturhistorisches Museum, Basel, Switzerland
NMV – National Museum of Victoria, Melbourne, Australia
PRI – Paleontological Research Institution, Ithaca, New York, USA
SDSNH – San Diego Natural History Museum, San Diego, California, USA
TBEG – Texas Bureau of Economic Geology, Austin, Texas, USA
TU – Tulane University, New Orleans, Louisiana, USA
UNAM – Universidad Nacional Autonoma de Mexico, Instituto de Geología, Mexico, D.F., Mexico

UNC – Department of Geology, University of North Carolina, Chapel Hill, North Carolina, USA
UCMP – Museum of Paleontology, University of California, Berkeley, California, USA
UF – Florida Museum of Natural History, University of Florida, Gainesville, Florida, USA
USNM – United States National Museum of Natural History, Washington, D.C., USA
WFIS – Wagner Free Institute of Science, Philadelphia, Pennsylvania, USA

IV. SYSTEMATIC DESCRIPTIONS

As in Part VIII, information on synonymies and localities given in earlier parts of this series generally will not be repeated. Only references that have appeared since the original treatment, or citations that have changed in some way will be included. Most references to Recent occurrences will not be included, except for the ones in two important books on the Muricidae (Radwin and D'Attilio, and Fair), which both appeared in 1976. This will not be absolute but in the interest of brevity it seems of little value to repeat material that is unchanged.

Family MURICIDAE Rafinesque, 1815
Subfamily MURICINAE Rafinesque, 1815
Genus PTERYNOTUS Swainson, 1833
Subgenus PTERYNOTUS s.s.

Pterynotus SWAINSON, 1833, Zool. Illus., (Ser. 2) v. 3, expl. to pl. 100.

Type species: *Murex pinnatus* Swainson, 1822, by subsequent designation, Swainson, *ibid.*, pl. 122.

Discussion: The name of the species that is the type of the genus *Pterynotus* was known for a short time (between 1967 and 1985) as *Pterynotus alatus* (Röding, 1798), as a result of Cernohorsky's discussion of the problem (1967, p. 122). Briefly, the problem is this: Röding named the species as *Purpura alata,* based upon Martini, 1777, figs. 1036, 1037. However, in the period when most workers considered almost all species of Muricinae as "*Murex,*" this taxon was considered to be a secondary homonym of *Murex alatus* Gmelin, 1791, and the later name *Murex pinnatus* Swainson, 1822, was applied to this well-known shell. Cernohorsky correctly pointed out that, as Röding's species was named originally in the genus *Purpura,* when transferred into the genus *Pterynotus,* as most modern workers would do, the secondary homonomy would no longer apply. This does not consider the fact that the name *Murex pinnatus* Swainson had been utilized since 1822 for this form.

The problem of rejecting well-known and long established names of species by little-known senior synonyms is one that the International Commission on Zoological Nomenclature wrestled with for years. In the 1985 edition of the *Code of Zoological Nomenclature* it was concluded: "The Principle of Priority is to be used to promote stability and is not intended to be used to upset a long-accepted name . . . An author who considers that the application of the Principle of Priority would disturb stability is to maintain existing usage and refer the case to the Commission for a ruling" [Art. 23(b)].

However, in the case of *Murex pinnatus,* this course was rendered unnecessary by the additional proviso that "a junior secondary homonym replaced before 1961 is permanently invalid" [Art. 59(b)]. Thus, *Purpura alata* Röding, 1798, a junior secondary homonym of *Murex alatus* Gmelin, 1791, and replaced by *Murex pinnatus* Swainson, 1822, is considered permanently invalid. Once again the name *Murex pinnatus* is the correct taxon for the type species of the genus *Pterynotus.*

In a review of the genus *Pterynotus* Harasewych and Jensen (1979) noted that there are at least four distinct lineages, which they believe provide insight into the evolution of the group, although they did not advocate separate subgenera. This situation arises in numerous genera and "Species Groups" have been used for this sort of distinction (*e.g.,* Ponder and Vokes, 1988, for *Murex* s.s.; Vokes, 1990, for *Chicoreus* s.s.). All four of these lineages are present in the fossil record of the western Atlantic, and it is deemed useful to present the same separation herein. As Harasewych and Jansen indicate, only three of the four groups are present today in the western Atlantic, but there are two fossil species that belong to the typical group of *P. pinnatus.* However, there also is a fifth group, here given as the "Species Group of *Pterynotus tricarinatus,*" which does not

occur anywhere in the Recent fauna (or, at least, has yet to be discovered).

Species Group 1: *Pterynotus guesti*

Discussion: This is, as stated by Harasewych and Jensen (1979, p. 2), the most primitive *Pterynotus* line, clearly showing affinities to early species of the genus *Paziella,* which I consider to be the ancestor of the entire *Poirieria-Pterynotus* "clan" (as used by Vokes, 1971a, p. 42).

PTERYNOTUS (PTERYNOTUS) MATTHEWSENSIS (Aldrich)
Plate 1, figures 1, 2

Pterynotus (Pterynotus) matthewsensis (Aldrich). VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 8, pl. 1, fig. 1.

Pterynotus matthewsensis (Aldrich). HARASEWYCH and JENSEN, 1979, Nemouria, no. 22, p. 3.

Holotype: USNM 638751; height (incomplete) 13 mm, diameter 8.2 mm.

Type locality: Matthews Landing Marl Member, Porters Creek Formation; Matthews Landing, Alabama River, Wilcox County, Alabama.

Occurrence: Matthews Landing Marl Member, Porters Creek Formation, Alabama.

Figured specimens: Fig. 1, PRI 24532; height 17.3 mm, diameter 7 mm; locality, Matthews Landing, Alabama River, Wilcox County, Alabama. Fig. 2, USNM 462672; height 11.8 mm, diameter (including spines) 5.8 mm; locality, Alabama River, at Dixon's Creek, Wilcox County, Alabama. Additional locality: TU 735.

Discussion: Pterynotus matthewsensis is not especially rare; we have collected several specimens near Kimbrough, Alabama (TU 735) and, at a site near the type locality on the Alabama River, David T. Dockery III of the Mississippi Bureau of Geology, collected over 20 specimens. All of these are relatively small, and the type remains the largest example seen.

The additional material reveals a "primitive" four whorl conical protoconch, with about seven thin lamellar varices on each of the first three teleoconch whorls. On the fourth whorl of the teleoconch this number is reduced to three varices per whorl. Comparing this Paleocene species with the Recent *P. guesti* (below), one can truly appreciate the conservative nature of the *Pterynotus* line.

PTERYNOTUS (PTERYNOTUS) STENZELI Vokes
Plate 1, figure 3

Pterynotus (Pterynotus) stenzeli VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 8, pl. 1, fig. 5.

Pterynotus stenzeli Vokes. HARASEWYCH and JENSEN, 1979, Nemouria, no. 22, p. 3.

Holotype: TBEG 36637; height 19 mm, diameter 11.3 mm.

Type locality: TBEG 173-T-19, Weches Formation; four miles [6.4 km] west of Chireno, hill on Texas Highway 21, Nacogdoches County, Texas [? = TU 1262].

Occurrence: Weches Formation, Texas.

Figured specimen: TBEG 36637 (holotype). Additional localities: TU localities 993, 1258, 1262, 1527.

Discussion: Although we have collected several additional specimens (mostly broken) of *P. stenzeli,* nothing can be added to the original description. As Harasewych and Jensen (1979, p. 3) observed, this Early Eocene species is closely related to the Recent *P. guesti.* Virtually the only difference is the protoconch, which in *P. stenzeli* is multispiral (three and one-half whorls) and in the Recent species is paucispiral (one and one-half whorls). Although the illustration of the holotype of *P. guesti* (reproduced here, pl. 1, fig. 4) does not show them especially well, there are also five to seven denticles on the inner side of the outer lip as in *P. stenzeli.*

PTERYNOTUS (PTERYNOTUS) GUESTI Harasewych and Jensen
Plate 1, figure 4

Pterynotus (Pterynotus) guesti HARASEWYCH and JENSEN, 1979, Nemouria, no. 22, p. 3, figs. 6 (holotype), 13 (distribution), 14 (protoconch).

Pterynotus guesti Harasewych and Jensen. ABBOTT and DANCE, 1982, Compendium of Seashells, p. 141 (holotype, color photograph); PETUCH, 1987, New Caribbean Moll. Faunas, p. 20, pl. 8, figs. 1, 2 (both holotype).

Holotype: DMNH 122258; height 28.6 mm.

Type locality: East-southeast of Key West, Florida, in 275 meters.

Occurrence: Recent only (known only from the type locality).

Figured specimen: DMNH 122258 (holotype; photograph courtesy of M.G. Harasewych).

Discussion: Described from deep water off the coast of Florida, this "living fossil" is one of two Recent species [the other being

the Japanese *P. vespertilio* (Kira, 1959)] that closely resemble the Paleogene species discussed above. These two Recent species are similar especially in coloration, which is a light tan with darker blotches on the varices. This can be seen in the color photographs of both species figured by Abbott and Dance (1982, p. 141).

At present there are no examples of this morphotype known between the Paleogene and the Recent, which reflects the fact that the line moved into deeper water after the Eocene and has been living there ever since.

Species Group 2: *Pterynotus "tricarinatus"*

Discussion: In the Eocene of the Paris Basin there are numerous species of *Pterynotus*. In this array we can see representatives of each of the Species Groups under discussion here. None are the earliest examples of their group but to see them all occurring together is unique to the Paris Basin fauna. Among these species we see the following: *P. tripteroides* (Lamarck, 1822), of the *phyllopterus* group; *P. micropterus* (Deshayes, 1835), of the *pinnatus* group; *P. bispinosus* (Sowerby, 1823), of the subgenus *Pterochelus;* and *P. fusoides* (Deshayes, 1865), which *may* have given rise to the subgenus *Purpurellus*. But the most common group of species can not be referred to any of the lines, and they are here placed in a separate group around the central species, the well known *P. tricarinatus* (Lamarck, 1803).

The several members of this group, including typical "*tricarinatus*" [= *Purpura*

PLATE 1

Figures Page

1, 2. *Pterynotus (Pterynotus) matthewsensis* (Aldrich) 5
1. (X 3) PRI 24532; height 17.3 mm, diameter 7 mm.
Locality: Matthews Landing, Alabama River, Wilcox County, Alabama; Matthews Landing Marl Member, Porters Creek Formation.
2. (X 4) USNM 462672; height 11.8 mm, diameter (including spines) 5.8 mm.
Locality: Alabama River, at Dixon's Creek, Wilcox County, Alabama; Matthews Landing Marl Member, Porters Creek Formation.

3. *Pterynotus (Pterynotus) stenzeli* Vokes (X 3) 5
TBEG 36637 (holotype); height 19 mm, diameter 11.3 mm.
Locality: TBEG 173-T-19, Nacogdoches County, Texas [? = TU 1262]; Weches Formation.

4. *Pterynotus (Pterynotus) guesti* Harasewych and Jensen (X 2) 5
DMNH 122258 (holotype); height 28.6 mm.
Locality: East-southeast of Key West, Florida, in 275 meters; Recent.
(Photograph courtesy of M. G. Harasewych)

5. *Pterynotus (Pterynotus) sabinola* (Palmer) (X 4) 9
PRI 3012 (holotype); height 16 mm, diameter 9 mm.
Locality: Stone City, Sabine River, Sabine County, Texas; Stone City Beds.

6. *Pterynotus (Pterynotus) propeposti* (Mansfield) (X 1 1/2) 8
USNM 49545 (holotype); height 43 mm, diameter 20 mm.
Locality: Blackwater Creek, at crossing of Seaboard Airline Railroad, Hillsborough County, Florida; Suwannee Limestone.

7. *Pterynotus (Pterynotus) aurorae* Garvie (X 2) 8
USNM 455527 (holotype); height 25 mm, diameter 12 mm.
Locality: Greggs Landing, Alabama River, Monroe County, Alabama; Bells Landing Marl Member, Tuscahoma Formation.

8. *Pterynotus (Pterynotus) weisbordi* (Palmer) (X 1 1/2) 8
Allen Coll.; height 38 mm, diameter 19 mm.
Locality: TU 99, Louisiana; Moodys Branch Formation.

9. *Pterynotus (Pterynotus) aliculus* Vokes (X 5) 9
USNM 365141 (holotype); height 10.3 mm, diameter 5.4 mm.
Locality: TU 1215, Dominican Republic; Gurabo Formation.

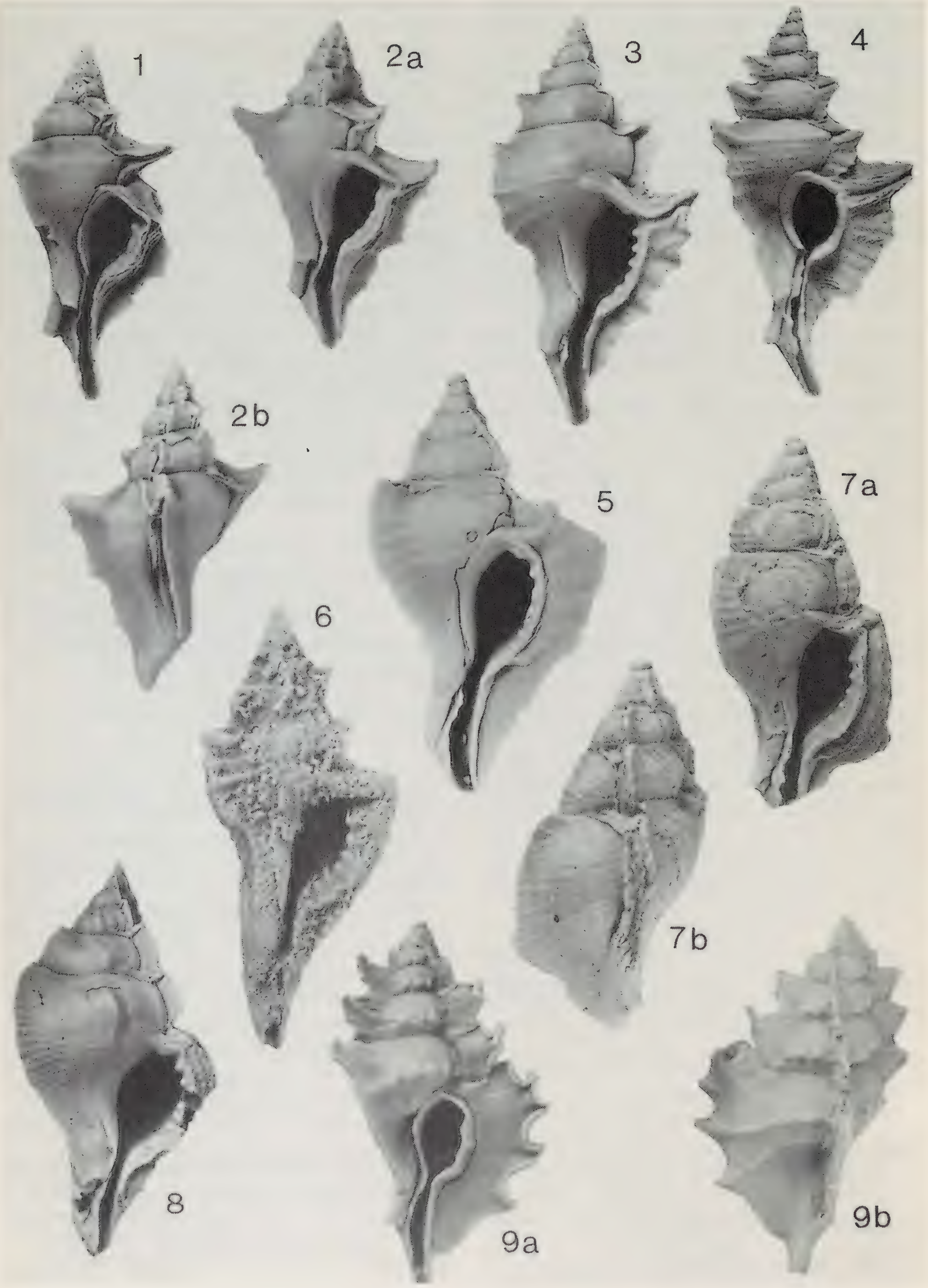


PLATE 1

crenulata Röding, 1798; both based on Brander, 1766, pl. 3, figs. 77, 79], *P. contabulatus* (Lamarck, 1803), and *P. tricuspidatus* (Deshayes, 1835) [= *Murex asper* Brander, 1766, pl. 3, fig. 78; not *M. asper* Linné, 1758], are characterized by having a denticulate aperture that folds into the shoulder spine to a much lesser degree than in the group of *P. guesti*. The shells are relatively scabrous, but not as much as in the group of *P. pinnatus*.

PTERYNOTUS (PTERYNOTUS) AURORAE Garvie
Plate 1, figure 7

Pterynotus (Pterynotus) aurorae GARVIE, 1991, Tulane Stud. Geol. Paleont., v. 24, no. 4, p. 89, pl. 1, figs. 3, 4.

Holotype: USNM 455527; height 25 mm, diameter 12 mm.

Type locality: Bells Landing Marl Member, Tuscahoma Formation; Greggs Landing, Alabama River, Monroe County, Alabama.

Occurrence: Bells Landing Marl Member, Tuscahoma Formation, Alabama.

Figured specimen: USNM 455527 (holotype).

Discussion: The recently described *P. aurorae* is unlike the other Paleocene species of *Pterynotus, P. matthewsensis,* in that it lacks the elongated infolding of the apertural lip into the shoulder spine. The overall morphology of the shell is most akin to the French Eocene species mentioned above, with a denticulate aperture and a small fold at the shoulder. The surface is also marked by numerous spiral cords. So far, this species is known only from the type specimen, but it is so completely distinctive that there is no question of it being a valid species.

As noted by Garvie, the Tuscahoma Formation has long been considered to be Early Eocene in age, but Siesser (1983) showed that the nannoplankton place it in zone NP.9, of Paleocene age.

PTERYNOTUS (PTERYNOTUS) WEISBORDI (Palmer)
Plate 1, figure 8

Pterynotus (Pterynotus) weisbordi (Palmer). VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 10, pl. 1, fig. 3 (holotype).

Holotype: PRI 4657; height 33.5 mm, diameter 15 mm.

Type locality: Moodys Branch Formation; Montgomery Landing, Red River, Grant Parish, Louisiana (= TU 99).

Occurrence: Moodys Branch Formation, Louisiana.

Figured specimen: Allen Coll.; height 38 mm, diameter 19 mm; locality TU 99.

Discussion: Unfortunately, the famous fossil collecting locality on the Red River at Montgomery Landing no longer exists. The Red River Waterway Project of the U.S. Corps of Engineers has resulted in the sharp bend of the river, formerly kept clear by erosion, being reduced to a silted-in and overgrown backwater. In the extensive collections made by Mr. James Allen, of Alexandria, Louisiana, before this "improvement," there is a particularly nice specimen of *P. weisbordi,* here illustrated (pl. 1, fig. 8), which shows that the species has a much greater resemblance to the Paris Basin Eocene species *P. crenulata* (Röding, 1798) [= *P. tricarinatus* Lamarck, see above] than previously noted. The American species differs from the French one in having finer, more numerous, spiral threads. Although I originally compared it to the French Eocene *P. tripteroides* (Lamark, 1822) this was due to the worn condition of the holotype.

PTERYNOTUS (PTERYNOTUS) PROPEPOSTI (Mansfield)
Plate 1, figure 6

Pterynotus (Pterynotus) propeposti (Mansfield). VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 11, pl. 1, fig. 4 (holotype).

Holotype: USNM 49545; height 43 mm, diameter 20 mm.

Type locality: Suwannee Limestone; Blackwater Creek, at crossing of Seaboard Airline Railroad, Hillsborough County, Florida.

Occurrence: Suwannee Limestone, Florida.

Figured specimen: USNM 49545 (holotype).

Discussion: Roger W. Portell, of the Florida Museum of Natural History, has collected additional specimens of *P. propeposti* at Terramar, Polk County, Florida; however, they are not as well preserved as the type.

Although Mansfield's choice of names suggests a relationship to *P. postii,* this is no more than generic and the species is most closely related to the French Eocene species *P. contabulatus* (Lamarck, 1803).

Species Group 3: *Pterynotus phaneus*

Discussion: Harasewych and Jensen (1979, p. 3) have indicated that this group is characterized by thin delicate shells, which lack scabrous surface ornament. They add that the subgeneric name *Timbellus* (type species: *Murex latifolius* Bellardi, 1872) has been proposed for this morphotype but I agree with them that the species should be retained within *Pterynotus* s.s.

PTERYNOTUS (PTERYNOTUS) SABINOLA
(Palmer)
Plate 1, figure 5

Pterynotus (Pterynotus) sabinola (Palmer). VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 9, pl. 1, fig. 2 (holotype).

Holotype: PRI 3012; height 16 mm, diameter 9 mm.

Type locality: Stone City Beds; Sabine River, Sabine County, Texas.

Occurrence: Stone City Beds, Texas; Cook Mountain Formation, Texas and Louisiana.

Figured specimen: PRI 3012 (holotype).

Discussion: Although Harasewych and Jensen (1979, p. 3) would trace the lineage of this Species Group to *P. tripteroides* (Lamarck, 1822), from the Paris Basin Eocene, I believe the latter is better placed with the group of *P. phyllopterus* (below). In any case, this line does go back to the Middle Eocene, in the guise of *P. sabinola*.

As anticipated, because most of the outcrop area in which this fossil occurs is now beneath the waters of Toledo Bend Reservoir, no additional material of this species has come to light and there is nothing new to be said about it.

PTERYNOTUS (PTERYNOTUS) ALICULUS Vokes
Plate 1, figure 9

Pterynotus (Pterynotus) aliculus VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 53, pl. 5, fig. 9.

Holotype: USNM 365141; height 10.3 mm, diameter 5.4 mm.

Type locality: TU 1215, Gurabo Formation; Rio Gurabo, bluffs on both sides, from the ford on Los Quemados-Sabaneta road upstream to approximately 1 km above the ford, Dominican Republic.

Occurrence: Gurabo Formation, Dominican Republic.

Figured specimen: USNM 365141 (holotype).

Discussion: Pterynotus aliculus is based upon a single specimen from the more shallow-water, coralline portion of the Gurabo Formation. In the original description it was compared to the Recent *P. xenos* Harasewych, 1982, another relatively shallow-water (60-70 meters) Recent species of *Pterynotus*. However, I believe the latter species is better placed with the Species Group of *P. phyllopterus*, pointing out the wisdom is not attempting to separate these various species into subgeneric taxa.

Although placed in the group of *P. phaneus*, this species differs from all other members in the group by the presence of a series of ball-like knobs circling the shell. I know of no other species of *Pterynotus* with this ornament, although some specimens of *P. phaneus* do have fairly strong intervarical ridges.

PTERYNOTUS (PTERYNOTUS) PHANEUS (Dall)
Plate 2, figures 1, 2

Pterynotus (Pterynotus) phaneus (Dall). VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 14, pl. 3, fig. 3 (holotype); ABBOTT, 1974, American Seashells, ed. 2, p. 175 (in part), not fig. 1856 (holotype, *Murex tristichus* Dall = *P. havanensis*); HARASEWYCH and JENSEN, 1979, Nemouria, no. 22, p. 4 (in part), figs. 1 (holotype, *Murex pygmaeus* Bush = *P. bushae* Vokes), 2 (holotype, *P. phaneus*), 4, 5, 17 (radula).

Pterynotus phaneus (Dall). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 100 (in part), not pl. 9, fig. 3 (= *P. havanensis*); FAIR, 1976, The Murex Book, p. 67, pl. 13, fig. 165 (holotype); ABBOTT and DANCE, 1982, Compendium of Seashells, p. 140 (color photograph).

Synonym:

Murex (Pteronotus) pygmaeus BUSH, 1893, Harvard Mus. Comp. Zool., Bull., v. 23, p. 213, pl. 1, figs. 3, 4.

Pterynotus (Pterynotus) bushae VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 13, pl. 3, fig. 2 (new name for *Murex pygmaeus* Bush, 1893, *non Muricites pygmäus* Schlotheim, 1820).

Pterynotus bushae Vokes. FAIR, 1976, The Murex Book, p. 28, pl. 13, fig. 163 (holotype, *Murex pygmaeus*).

Holotype: USNM 93256 (*Murex phaneus* Dall); height 17 mm, diameter 7 mm.

Type locality: *Albatross* Station 2662, off St. Augustine, Florida, in 434 fathoms [794 meters].

Occurrence: Recent only, eastern coast of North America.

Figured specimens: Fig. 1, USNM 93256 (holotype, *P. phaneus*). Fig. 2, MCZ 6918 (holotype, *Murex pygmaeus*); height 16 mm, diameter 8.5 mm; locality, *Blake* Station 319, off Charleston, South Carolina, in 262 fathoms [479 meters].

Discussion: The three species of *Pterynotus* described from the deeper water off the eastern United States have been placed in synonymy by Abbott (1974, p. 175), Radwin and D'Attilio (1976, p. 100), and Harasewych and Jensen (1979, p. 4). I accept their synonymy of *P. bushae* with *P. phaneus;* however, there is one fundamental difference between these two and the third species, *P. havanensis,* in that the early teleoconch whorls in the latter have six lamellar varices per whorl (see pl. 2, fig. 3), in contrast to only three in the others (pl. 2, figs. 1, 2). Also, the shell ornamentation is more pronounced in *P. phaneus/bushae.*

Because of the confusion between the two species, locality information in the above references is not reliable but it appears that *P. phaneus* occurs from South Carolina to Quintana Roo, Mexico, and *P. havanensis* occurs from Florida to northern South America.

PTERYNOTUS (PTERYNOTUS) HAVANENSIS Vokes

Plate 2, figures 3, 6

Pterynotus (Pterynotus) havanensis VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 13, pl. 3, fig. 1 (new name for *Murex tristi-*

PLATE 2

Figures Page

1, 2. *Pterynotus (Pterynotus) phaneus* (Dall) (X 10) 9
1. USNM 93256 (holotype); height 17 mm, diameter 7 mm.
Locality: *Albatross* Station 2662, off St. Augustine, Florida, in 434 fathoms [794 meters]; Recent.
2. MCZ 6918 (holotype, *Murex pygmaeus* Bush); height 16 mm, diameter 8.5 mm.
Locality: *Blake* Station 319, off Charleston, South Carolina, in 262 fathoms [479 meters]; Recent.

3, 6. *Pterynotus (Pterynotus) havanensis* Vokes 10
3. (X 10) MCZ 7308 (holotype, *Murex tristichus* Dall); height 15.5 mm, diameter 10 mm.
Locality: *Blake* Station 51, off Havana, Cuba, in 400 fathoms [732 meters]; Recent.
6. (X 4) USNM 462673; height (incomplete) 13.8 mm, diameter (incomplete) 7 mm.
Locality: TU 1240, Costa Rica; Moín Formation.

4. *Pterynotus (Pterynotus) radwini* Harasewych and Jensen (X 2) 12
DMNH 122424 (holotype); height 30.9 mm.
Locality: R/V *Pillsbury* Station P-610, east of Turneffe Islands, Belize, in 296-329 meters; Recent.
(Photograph courtesy of M.G. Harasewych)

5. *Pterynotus (Pterynotus) lightbourni* Harasewych and Jensen (X 2) 12
DMNH 122259 (holotype); height 33.8 mm.
Locality: Off St. David's, Bermuda, in 275-600 meters; Recent.
(Photograph courtesy of M.G. Harasewych)

7. *Pterynotus (Pterynotus) burnsii* (Aldrich) (X 1) 14
USNM 135155 (holotype); height 67.5 mm, diameter 33 mm.
Locality: Carson's Creek, Wayne County, Mississippi (? = TU 1290); Red Bluff Formation.

8. *Pterynotus (Pterynotus) postii* (Dall) (X 1 3/4) 16
USNM 130349 (holotype); height 38 mm, diameter 21 mm.
Locality: Ballast Point, Tampa Bay, Hillsborough County, Florida; Tampa Limestone.

9. *Pterynotus (Pterynotus) hoerlei* Vokes (X 2) 16
USNM 429797; height 33 mm, diameter 15 mm.
Locality: TU 555, Florida; Chipola Formation.

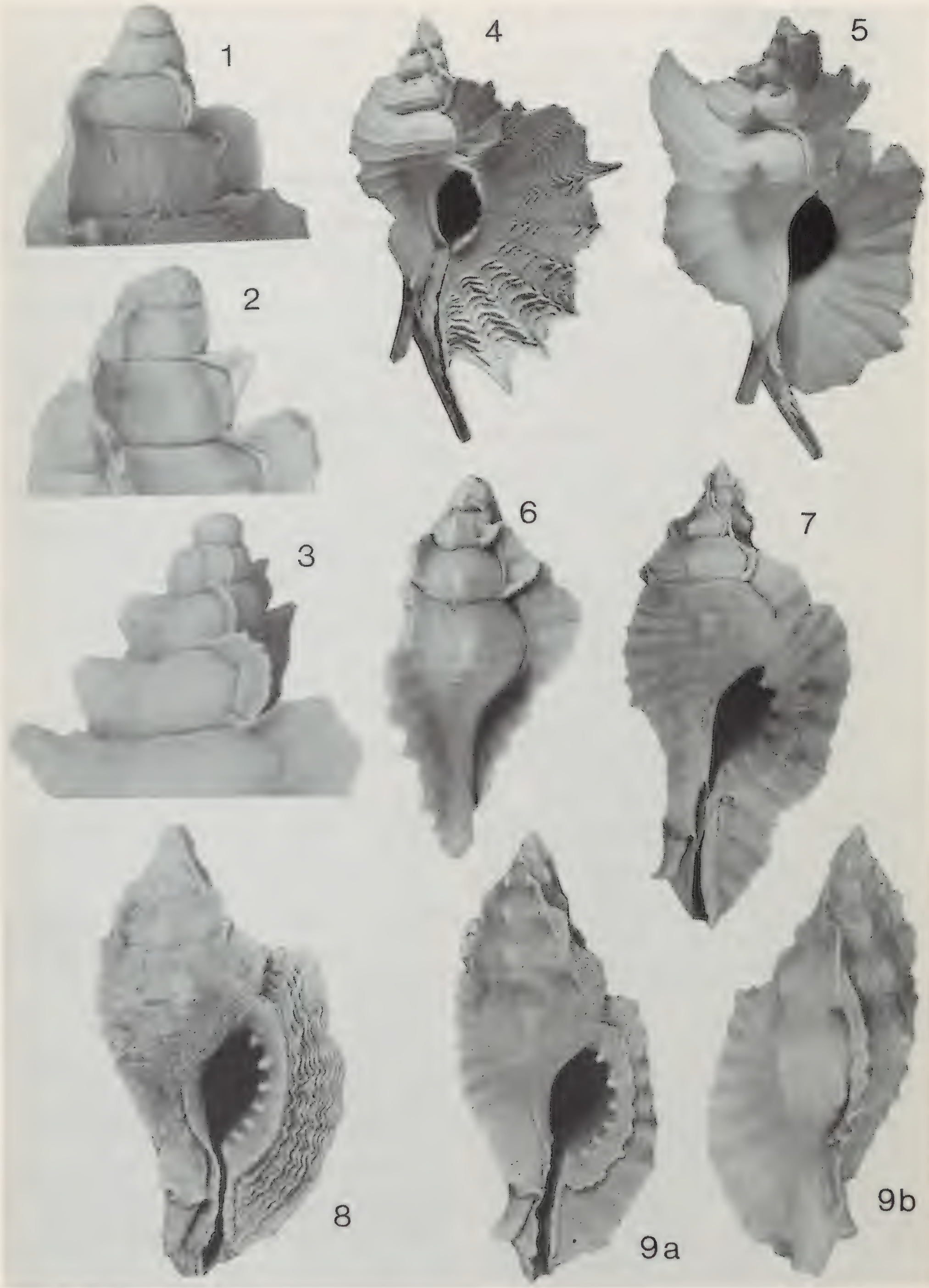


PLATE 2

chus Dall, 1889, *non M. tristichus* Beyrich, 1854).

Pterynotus (Pterynotus) phaneus (Dall). ABBOTT, 1974, American Seashells, ed. 2, p. 175 (in part), fig. 1856 (holotype, *M. tristichus*); HARASEWYCH and JENSEN, 1979, Nemouria, no. 22, p. 4 (in part), figs. 3 (holotype, *M. tristichus*), 16 (protoconch, *P. havanensis*) only.

Pterynotus phaneus (Dall). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 100 (in part), pl. 9, fig. 3.

Pterynotus havanensis Vokes. FAIR, 1976, The Murex Book, p. 47, pl. 13, fig. 164 (holotype, *M. tristichus*).

Holotype: MCZ 7308 (holotype, *Murex tristichus* Dall); height 15.5 mm, diameter 10 mm.

Type locality: *Blake* Station 51, off Havana, Cuba, in 400 fathoms [732 meters].

Occurrence: Moín Formation, Costa Rica; Recent, eastern North America to Colombia.

Figured specimens: Fig. 3, MCZ 7308 (holotype, *Murex tristichus*). Fig. 6, USNM 462673; height (incomplete) 13.8 mm, diameter (incomplete) 7 mm; locality TU 1240.

Discussion: As noted above, I consider *P. havanensis* to be separable from *P. phaneus* by the more numerous varices on the early teleoconch whorls in *P. havanensis*. This is well illustrated in the drawing given by Harasewych and Jensen (1979, fig. 16), which is said to be *P. phaneus* but is actually *P. havanensis* (compare pl. 2, figs. 1, 3). In these shells in which all species look alike, minor differences such as these assume greater importance. In addition, the shell surface in *P. havanensis* is smoother than the more ornamented *P. phaneus*, but both species have denticulations on the inner side of the outer lip and in most the margins of the varices are drawn out into five digitations, corresponding to the spaces *between* the denticulations.

Hitherto this species has not been reported south of Havana, Cuba. In my collection there is a single specimen of *P. havanensis* taken in the Golfo de Urabá, Colombia, at 100 meters, which considerably extends the range. This is further corroborated by a broken specimen (pl. 2, fig. 6), which appears to be *P. havanensis* (although without the early whorls one cannot be sure) from the Pleistocene Moín Formation, Costa Rica (TU 1240).

PTERYNOTUS (PTERYNOTUS) RADWINI Harasewych and Jenson
Plate 2, figure 4

Pterynotus (Pterynotus) radwini HARASEWYCH and JENSEN, 1979, Nemouria, no. 22, p. 11, figs. 10 (holotype), 13 (distribution), 18 (radula).

Pterynotus radwini Harasewych and Jensen. ABBOTT and DANCE, 1982, Compendium of Seashells, p. 141 (holotype, color photograph); PETUCH, 1987, New Caribbean Moll. Faunas, p. 62, pl. 10, figs. 10, 11 (both holotype).

Pterynotus (Timbellus) radwini Harasewych and Jensen. PETUCH, 1988, Neogene Hist. Trop. Amer. Moll., p. 155, pl. 33, figs. 3, 4 (both holotype).

Holotype: DMNH 122424; height 30.9 mm.

Type locality: R/V *Pillsbury* Station P-610, east of Turneffe Islands, Belize, in 296-329 meters.

Occurrence: Recent only (known only from type locality).

Figured specimen: DMNH 122424 (holotype; photograph courtesy of M.G. Harasewych).

Discussion: Based upon a single spectacular specimen, this species is distinguished from the following equally large species by the presence of strong spiral cords that lead to elongate digitations along the varical margin.

PTERYNOTUS (PTERYNOTUS) LIGHTBOURNI Harasewych and Jensen
Plate 2, figure 5

Pterynotus (Pterynotus) lightbourni HARASEWYCH and JENSEN, 1979, Nemouria, no. 22, p. 8, figs. 7-9 (holotype, paratypes), 13 (distribution), 15 (protoconch).

Pterynotus lightbourni Harasewych and Jensen. ABBOTT and DANCE, 1982, Compendium of Seashells, p. 141 (holotype, color photograph).

Holotype: DMNH 122259; height 33.8 mm.

Type locality: Off St. David's, Bermuda, in 275-600 meters.

Occurrence: Recent only (known only from the type locality).

Figured specimen: DMNH 122259 (holotype; photograph courtesy of M.G. Harasewych).

Discussion: Known only from the three specimens in the original type lot, this deep-water species is said to be distinguished from other members of the group by the appearance of three light brown color patches along the outer margin of the

aperture. The color photograph of the holotype given by Abbott and Dance (1982, p. 141) does not indicate that these patches are very prominent. The shell appears to be monochromatic, as are all other members of this Species Group.

Species Group 4: *Pterynotus pinnatus*

Discussion: Harasewych and Jensen (1979) did not include the "typical" group in their treatment, as there are no living examples of this line in the New World. Nevertheless, there are two fossil examples, one species each from the Early Miocene Chipola Formation and from the Late Miocene-Early Pliocene Gurabo Formation. Although the Chipola species is the oldest representative of the line in the New World, there is a Cuisian (Early/Middle Eocene) form described from the Aquitaine Basin of France, "*Marchia*" [*sensu* Radwin and D'Attilio, 1976] *antiqua* Merle, 1989, which indicates the line probably originated in the Old World.

PTERYNOTUS (PTERYNOTUS) PRAEPATAGIATUS
Vokes, n. sp.
Plate 3, figures 1-3

Pterynotus pinnatus (Swainson). VOKES, 1972, Tulane Stud. Geol. Paleont., v. 10, no. 1, p. 29, text-fig. 2 (not of Swainson).

Description: Protoconch of four or five conical whorls (none complete in the type material), ending at a sharply recurved varix; seven teleoconch whorls in the adult. Axial ornamentation on the first two teleoconch whorls of nine foliaceous lamellae, becoming seven raised ridges on third and fourth whorls; on the fifth teleoconch whorl every other one of these ridges becoming a swollen varix, with the alternating ridge remaining as an intervarical node (three varices alternating with nodes on each whorl). Varices formed by multiple layers of shell material, the adapertual face laciniated by spiral ornamentation. The outermost layer of the varices extended as a single lamellar flange, widest along the anterior portion. In addition to major axial sculpture, shell surface covered by numerous growth lamellae, on the order of 20 between each pair of varices; each elaborately fimbriated by invisible spiral threads as well as by the visible spiral cords, giving the entire shell surface the appearance of being covered by a net. Spiral ornamentation on first teleoconch whorl of three small cords; by third teleoconch whorl these alternating with smaller intercalated secondary cords, the latter gradually becoming equal in strength to the major cords. Body whorl and siphonal canal with about 20 almost equi-sized spiral cords, plus random intercalated secondary cords and several secondary cords on the subsutural slope and distal end of the siphonal canal. Suture appressed, the growth lamellae from the succeeding whorl forming a frilled cover hiding the exact line of suture. Aperture elongate-oval; inner lip smooth, appressed at posterior end, with an expanded flare reaching to the intervarical node of the adjacent whorl; inner side of outer lip with about nine small denticles. Siphonal canal moderately long, recurved at the distal end, with previous canals diverging at an angle; almost closed but open by a narrow slit.

Holotype: USNM 646949; height 34.4 mm, diameter 16.2 mm.

Type locality: TU 830, Chipola Formation; Tenmile Creek, at power line crossing about one mile [1.6 km] west of Chipola River (SE 1/4 Sec. 12, T1N, R10W), Calhoun County, Florida.

Etymology of name: From the resemblance to the Recent *P. patagiatus* (Hedley, 1912).

Occurrence: Chipola Formation, Florida.

Figured specimens: Fig. 1, USNM 646949 (holotype). Fig. 2, USNM 462674 (paratype A); height 21.8 mm, diameter 12.2 mm; locality TU 951. Fig. 3, Schmelz Coll. (paratype B); height 35.5 mm, diameter 15.8 mm; locality TU 951.

Discussion: On the basis of a single incomplete specimen from Tenmile Creek, this species was referred (Vokes, 1972) to the Recent Indo-Pacific type of the genus, *P. pinnatus,* noting that the occurrence was most unlikely. Since that report, two additional specimens have been collected by Gary Schmelz, Naples, Florida (paratypes A and B) and from paratype A it can be seen that, although the Chipola specimens do bear an strong resemblance to *P. pinnatus*, there is a marked difference in the development of the early teleoconch whorls (*not* the protoconchs, which are probably the same).

As may be seen in the illustrations, the first two teleoconch whorls in *P. pinnatus* (pl. 3, fig. 6) have about six small lamellar varices. Then on the third teleoconch whorl the number is reduced to only three varices per whorl, with a strong intervarical node between each pair. In the Chipola species (pl. 3, fig. 2c) the first two teleoconch whorls have about nine lamellar varices, then on the third and fourth

whorls there are about seven varices. These are reduced to three per whorl only at about the fifth teleoconch whorl. In this aspect the Chipola species is more similar to the Recent *P. patagiatus* (Hedley, 1912) from eastern Australia than to *P. pinnatus;* however, the protoconch in the Australian species has one and one-half bulbous whorls (pl. 3, fig. 4c). The general shape of the shell in the Chipola species is also similar to *P. patagiatus,* with more inflated whorls and a more recurved siphonal canal than in *P. pinnatus.*

The usual evolutionary development of species in the Muricinae is from a multiwhorl protoconch to a paucispiral one. Because of this and the similar early teleoconch this new species appears more closely related to the Australian species than to *P. pinnatus.*

Thus, we see yet another Tertiary western Atlantic muricine species with its closest Recent relatives living today in Australia (see Vokes, 1974). This, undoubtedly, is due to the "relict" nature of the Australian mollusk fauna rather than to any extraordinary inter-ocean transport.

PTERYNOTUS (PTERYNOTUS) NEOTRIPTERUS
Vokes
Plate 3, figure 5

Pterynotus (Pterynotus) neotripterus VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 54, pl. 5, figs. 2, 3.

Holotype: USNM 323880; height 40.2 mm, diameter 18 mm.

Type locality: TU 1277, Gurabo Formation; Río Gurabo, both sides, upstream from the horsetrail to 0.5 km above the trail, or approximately 2 km (airline) to 2.5 km above the ford on Los Quemados-Sabaneta road, Dominican Republic.

Occurrence: Gurabo Formation, Dominican Republic.

Figured specimen: USNM 323880 (holotype). Additional localities: TU 1211, 1219, 1225, 1231, 1250.

Discussion: Known from eight specimens collected in the more shallow water portions of the Gurabo Formation, Dominican Republic, *P. neotripterus* is the second New World representative of the typical *Pterynotus* group. It differs from the new species above, *P. praepatagiatus,* in the longer siphonal canal, with a varical flange extending along its entire length. As the name implies, this species is akin to the Recent Indo-Pacific *P. tripterus* (Born, 1778), not only in the broad siphonal flange but also in the rather triangular aperture, with denticles on the columellar lip.

Species Group 5: *Pterynotus phyllopterus*

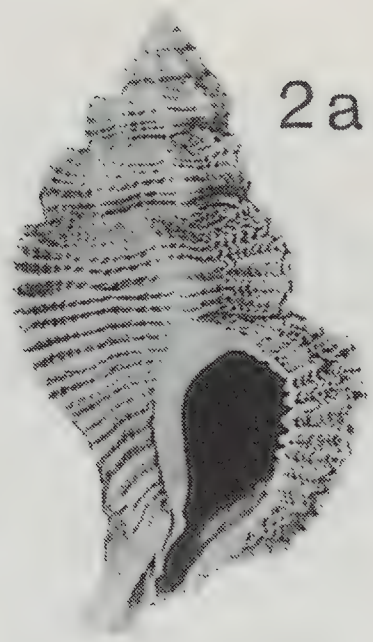
PTERYNOTUS (PTERYNOTUS) BURNSII
(Aldrich)
Plate 2, figure 7

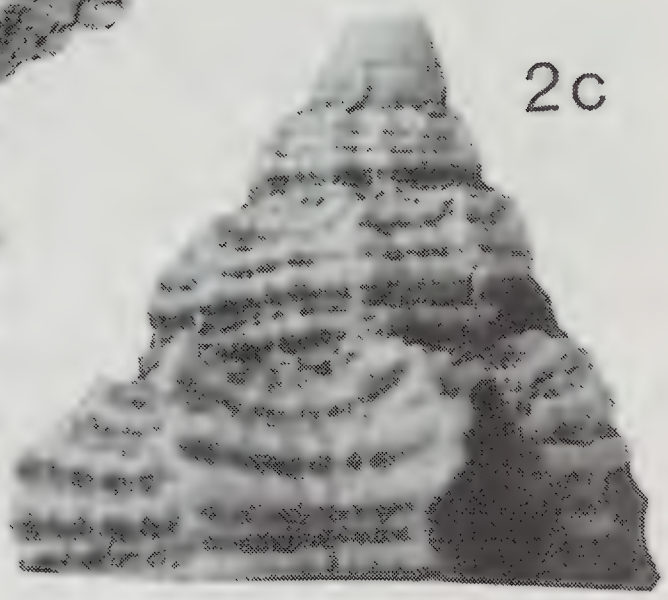
Pterynotus (Pterynotus) burnsii (Aldrich). VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 10, pl. 2, fig. 1 (holotype); MACNEIL and DOCKERY, 1984, Mississippi Bur.

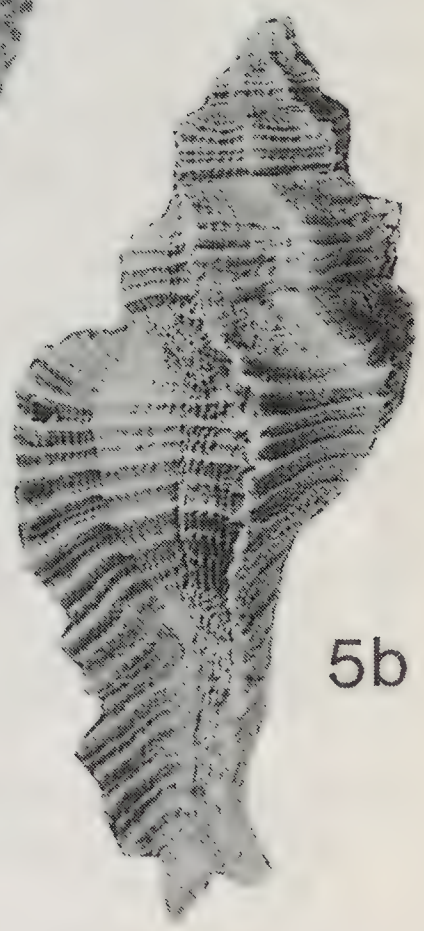
PLATE 3

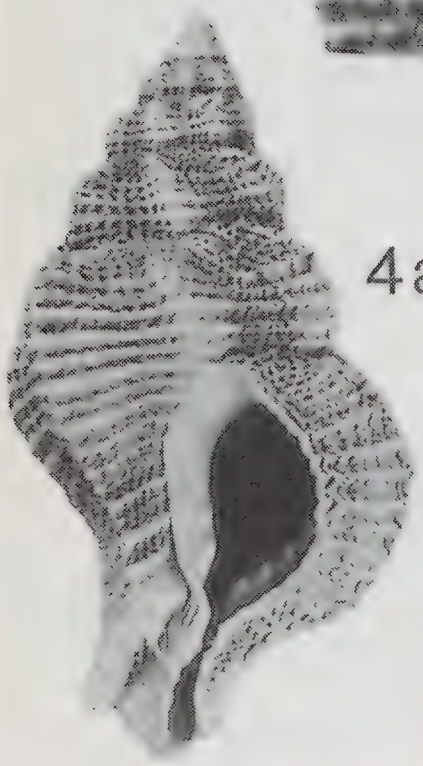
Figures Page

1-3. *Pterynotus (Pterynotus) praepatiagatus* Vokes, n. sp. (X 2) 13
1. USNM 646949 (holotype); height 34.4 mm, diameter 16.2 mm.
Locality: TU 830, Florida; Chipola Formation.
2. (2c X 10) USNM 462674 (paratype A); height 21.8 mm, diameter 12.2 mm.
Locality: TU 951, Florida; Chipola Formation.
3. Schmelz Coll. (paratype B); height 35.5 mm, diameter 15.8 mm.
Locality: TU 951, Florida; Chipola Formation.
4. *Pterynotus (Pterynotus) patagiatus* (Hedley) (X 2) 14
(4c X 10) USNM 869505; height 26 mm, diameter 13.7 mm.
Locality: Keppel Bay, Australia; Recent.
5. *Pterynotus (Pterynotus) neotripterus* Vokes (X 1 1/2) 14
USNM 323880 (holotype); height 40.2 mm, diameter 18 mm.
Locality: TU 1277, Dominican Republic; Gurabo Formation.
6. *Pterynotus (Pterynotus) pinnatus* (Swainson) (X 10) 13
Vokes Coll.; height 38 mm, diameter 16.3 mm.
Locality: Kii, Japan; Recent.









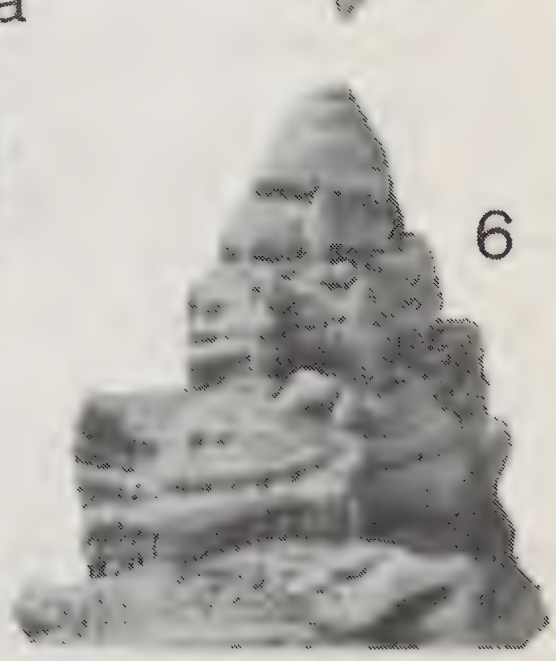


PLATE 3

Geol., Bull. 124, p. 124, pl. 5, figs. 1, 2 (holotype).

Synonym:

Murex (Pteronotus) grandispinosa ALDRICH, 1895, Bulls. Amer. Paleontology, v. 1, no. 2, p. 66. Unnecessary new name for *M. burnsii* Aldrich, 1894, not *M. burnsii* Whitfield *in* Dall, 1890 [nude name].

Holotype: USNM 135155; height 67.5 mm, diameter 33 mm.

Type locality: Red Bluff Formation; Carson's Creek, 1 1/2 to 2 miles [2.5 to 3 km] west [east] of Red Bluff (Chickasawhay River), Wayne County, Mississippi (? = TU 1290).

Occurrence: Red Bluff Formation, Mississippi.

Figured specimen: USNM 135155 (holotype). Additional localities: TU 1288, 1289.

Discussion: Since my original discussion of this species, we have collected two additional examples from the banks of the Chickasawhay River near Red Bluff (TU 1288, 1289), and MacNeil and Dockery (1984, p. 125) also report the species from MGS locality 37 (Red Bluff = TU 1288). A search was made for Aldrich's "Carson Creek" locality but the closest we could find is "Carson Sand Creek" (TU 1290), where this species has not been collected. But it must be noted that whether it is Carson Creek or Carson Sand Creek, the type locality is *east* of Red Bluff and not *west* (which would be on the other side of the Chickasawhay River), as stated on the label with the type specimen.

PTERYNOTUS (PTERYNOTUS) RUFIRUPICOLUS (Dall)

Pterynotus (Pterynotus) rufirupicolus (Dall). VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 12.

Holotype: USNM 166725; height 42 mm, diameter 19 mm.

Type locality: Flint River Formation; Red Bluff, west bank Flint River, seven miles [11 km] above Bainbridge, Decatur County, Georgia.

Occurrence: Flint River Formation, Georgia.

Discussion: Nothing more is known about this species based upon a single internal mold, but it may be the same as the contemporary *P. postii*. However, the two cannot be put in synonymy with no better material than now available.

PTERYNOTUS (PTERYNOTUS) POSTII (Dall)
Plate 2, figure 8

Pterynotus (Pterynotus) postii (Dall). VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 12, pl. 2, fig. 2 (holotype).

Holotype: USNM 130349; height 38 mm, diameter 21 mm.

Type locality: Tampa Limestone; Ballast Point, Tampa Bay, Hillsborough County, Florida.

Occurrence: Tampa Limestone, Florida.

Figured specimen: USNM 130349 (holotype).

Discussion: The Tampa Limestone is now believed to be latest Oligocene (Chickasawhayan Stage) rather than Early Miocene, as previously considered. Nothing more can be added to the discussion of this species.

PTERYNOTUS (PTERYNOTUS) HOERLEI Vokes
Plate 2, figure 9

Pterynotus (Pterynotus) hoerlei VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 12, pl. 2, fig. 3; VOKES, 1972, Earth Science, v. 25, no. 3, p. 124, pl. 2, fig. 7.

Pterynotus hoerlei Vokes. HARASEWYCH and JANSEN, 1979, Nemouria, no. 22, p. 14.

Holotype: USNM 645616; height 59 mm, diameter 29.5 mm.

Type locality: TU 547, Chipola Formation; west bank of Chipola River (SW 1/4 Sec. 29, T1N, R9W), Calhoun County, Florida.

Occurrence: Chipola Formation, Florida.

Figured specimen: USNM 429797; height 33 mm, diameter 15 mm; locality TU 555. Additional localities: TU 825, 830, 1048, 1196.

Discussion: Since *P. hoerlei* was described, we have collected several fragments but nothing equal to the holotype. However, these do extend the area of occurrence to Tenmile Creek (TU 830) and to Farley Creek, along which it occurs at three localities (TU 825, 1048, 1196). Two of these are the shallowest of all Chipola localities, occurring at what was the Chipola shoreline. Nevertheless, most specimens have come from TU 555, a coral-reef locality on the Chipola River. One of these, in the Hoerle Collection at the U.S. National Museum, is figured here (pl. 2, fig. 9).

PTERYNOTUS (PTERYNOTUS) PHYLLOPTERUS
(Lamarck)
Plate 4, figures 1-3

Murex phyllopterus LAMARCK, 1822, Anim. sans Vert., v. 7, p. 164; KIENER, 1842, Coquille Vivantes, v. 7, Genre Rocher, p. 103, pl. 24, fig. 1; CERNOHORSKY, 1971, Veliger, v. 14, no. 2, p. 189, fig. 5 (holotype).

Pterynotus (Pterynotus) phyllopterus (Lamarck). EMERSON and OLD, 1972, Veliger, v. 14, no. 4, p. 350, figs. 1-13 (figs. 7-10 = syntypes, *Murex rubridentatus* Reeve); HARASEWYCH and JENSEN, 1979, Nemouria, no. 22, p. 12, figs. 11, 12 (shell), 13 (distribution), 19 (radula); VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 52, pl. 5, fig. 1.

Pterynotus phyllopterus (Lamarck). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 100, pl. 7, fig. 8; FAIR, 1976, The Murex Book, p. 67, pl. 13, fig. 157 (holotype); ABBOTT and DANCE, 1982, Compendium of Seashells, p. 140 (color photograph); SUTTY, 1986, Seashell Treasures Caribbean, p. 52, fig. 52 (color photographs).

Synonym:

Murex rubridentatus REEVE, 1846, Conch. Icon., v. 3, *Murex*, pl. 36, fig. 186.

Holotype: MHNG 1099/27; height 83.4 mm (*fide* Cernohorsky, 1971, p. 188).

Type locality: Martinique (designated by Emerson and Old, 1972, p. 552).

Occurrence: Gurabo Formation, Dominican Republic; Tamiami Formation, Florida; Moín Formation, Costa Rica; Recent, Windward Islands.

Figured specimens: Fig. 1, Wright Coll.; height 63.1 mm, diameter 33.4 mm; locality, reef off Club Méditerranée, Martinique. Fig. 2, USNM 462675; height (incomplete) 27 mm, diameter 16 mm; locality TU 1175. Fig. 3, USNM 462676; height (as is) 41.4 mm, diameter (as is) 18.1 mm; locality TU 1489. Additional localities: TU 954, 1231, 1240.

Discussion: In 1970, I observed that *Pterynotus hoerlei* "is closely related to the Recent Indo-Pacific species *P. phyllopterus* (Lamarck)" (Vokes, 1970, p. 13). In 1972 Emerson and Old reported specimens of this strikingly beautiful species from the island of Martinique, in the Lesser Antilles. The form lives in relatively shallow water, about 30 meters in depth, and that specimens of this large species remained undiscovered for such a long time is utterly amazing. Sutty (1986, p. 52) describes finding the first specimens of this "new" species in 1969 and she observes that the animal usually hides "in small but deep hollows of rock or madrepore," rarely straying from its dwelling place. Presumably this is how it eluded capture for so long.

Many living examples have been taken since the original report, and the range has been extended to Guadeloupe, but this seems to be the extent of its range today. However, in earlier geologic times it had a much greater range, occurring (mostly as fragments today) in the Dominican Republic in the Late Miocene/Early Pliocene (TU 1231), southern Florida in the mid-Pliocene (TU 1175), and Costa Rica in the Pleistocene (TU 954, 1240, 1489). All of these localities have coralline material associated with them, and it is apparent that the species has always inhabited coral-reefs. The locality at TU 1175 was originally referred to the Caloosahatchee Formation (Vokes, 1989b, p. 53) but in a study of these southwestern Florida coral-reefs, Meeder (1990) has assigned the beds to the Tamiami Formation.

The *P. phyllopterus* line goes back in the New World to the Early Oligocene *P. burnsii*, almost without change. In addition, in the Miocene of Italy there are two(?) other species described by Bellardi as *Murex perlongus* (1872, p. 75, pl. 5, fig. 8) and *Murex rovasendae* (*ibid.*, p. 75, pl. 5, fig. 9). The latter almost certainly is the same as *P. phyllopterus; M. perlongus* lacks the triangular shoulder extension to the fronds but this is probably due to wear. As the two occur at the same locality (Torino Hills) it seems likely that they are, in fact, two examples of the same species and are both synonyms of *P. phyllopterus*.

PTERYNOTUS (PTERYNOTUS) XENOS
Harasewych
Plate 4, figure 4

Murex tristichus Dall. HUMFREY, 1975, Sea Shells of the West Indies, p. 136, pl. 22, fig. 35 (not of Dall).

Pterynotus (Pterynotus) xenos HARASEWYCH, 1982, Biol. Soc. Washington, Proc., v. 95, no. 4, p. 639, figs. 1-3.

Pterynotus xenos Harasewych. CRNKOVIC, 1992, Texas Conch., v. 28, no. 2, p. 42, text-figs. 1, 2.

Holotype: USNM 703309; height 6.3 mm, diameter 3.7 mm.

Type locality: Discovery Bay, Jamaica, in 60 meters.

Occurrence: Recent only, Jamaica and Cuba to Honduras.

Figured specimen: USNM 703309 (holotype).

Discussion: Based upon five small specimens (the known maximum size of the species is less than 7 mm), all from the type locality, this species originally was figured by Humfrey (1975, pl. 22, fig. 35) as *P. tristichus* (Dall), a form only generically similar. When described, Harasewych (1982, p. 641) suggested that its closest relative "will likely prove to be *P. tripterus* (Born, 1778) from the Indo-Pacific." However, *P. xenos* lacks the scabrous surface ornamentation characteristic of the typical Species Group, to which I would refer *P. tripterus*. The similarity between the two forms is the denticulate aperture, a character that also occurs in the Group of *P. phyllopterus*, and, in spite of the small size, I consider this to be the species closest to *P. xenos*.

In the original description Harasewych noted that the inner lip is smooth, although the holotype has a single large denticle on the columellar lip (see pl. 4, fig. 4). Presumably it is pathologic, for the figured paratype does not show such a structure nor does the specimen in my collection. The latter was collected by Hortensia Sarasua from the sands dredged to form the Havana harbor and was the only example known from anywhere other than the type locality until Crnkovic (1992) reported the species from 14 meters depth off Isla Roatan, Honduras. The scarceness of this relatively shallow-water species probably is due more to its small size than to actual rarity.

Subgenus PTEROCHELUS Jousseaume, 1880

Pterochelus JOUSSEAUME, 1880, Le Naturaliste, Année 2, no. 42, p. 335.

Type species: *Murex acanthopterus* Lamarck, 1816, by original designation.

PLATE 4

Figures Page

1-3. *Pterynotus (Pterynotus) phyllopterus* (Lamarck) 17
1. (X 1 1/4) Wright Coll.; height 63.1 mm, diameter 33.4 mm.
Locality: Reef off Club Méditerranée, Martinique; Recent.
2. (X 1 1/2) USNM 462675; height (incomplete) 27 mm, diameter 16 mm.
Locality: TU 1175, Florida; Tamiami Formation.
3. (X 1 1/4) USNM 462676; height (as is) 41.4 mm, diameter (as is) 18.1 mm.
Locality: TU 1489, Costa Rica; Moín Formation.

4. *Pterynotus (Pterynotus) xenos* Harasewych (X 10) 17
USNM 703309 (holotype); height 6.3 mm, diameter 3.7 mm.
Locality: Discovery Bay, Jamaica, in 60 meters; Recent.

5. *Pterynotus (Pterochelus) angelus* (Aldrich) (X 2) 20
USNM 644608 (holotype); height 26 mm, diameter 14 mm.
Locality: Red Bluff, Chickasawhay River, Wayne County, Mississippi (= TU 1288); Red Bluff Formation.

6. *Pterynotus (Pterochelus) ariomus* (Clench and Pérez Farfante) (X 2) 20
MCZ 164734 (holotype); height 24 mm, diameter 12.5 mm.
Locality: Off Hollywood, Florida, in 50-60 fathoms [91-109 meters]; Recent.

7, 8. *Pterynotus (Purpurellus) mirificus* Vokes 21
7. (X 2) USNM 323885 (holotype); height 29.6 mm, diameter 17.6 mm.
Locality: TU 1215, Dominican Republic; Gurabo Formation.
8. (X 10) USNM 323884 (paratype B); height (incomplete) 13.5 mm, diameter (incomplete) 11.9 mm.
Locality: TU 1215, Dominican Republic; Gurabo Formation.

9. *Pterynotus (Purpurellus) repetiti* Vokes (X 1 1/4) 21
USNM 646438 (holotype); height (incomplete) 53.5 mm, diameter 28 mm.
Locality: TU 866, North Carolina; "Silverdale Beds" (= Haywood Landing Member, Belgrade Formation).

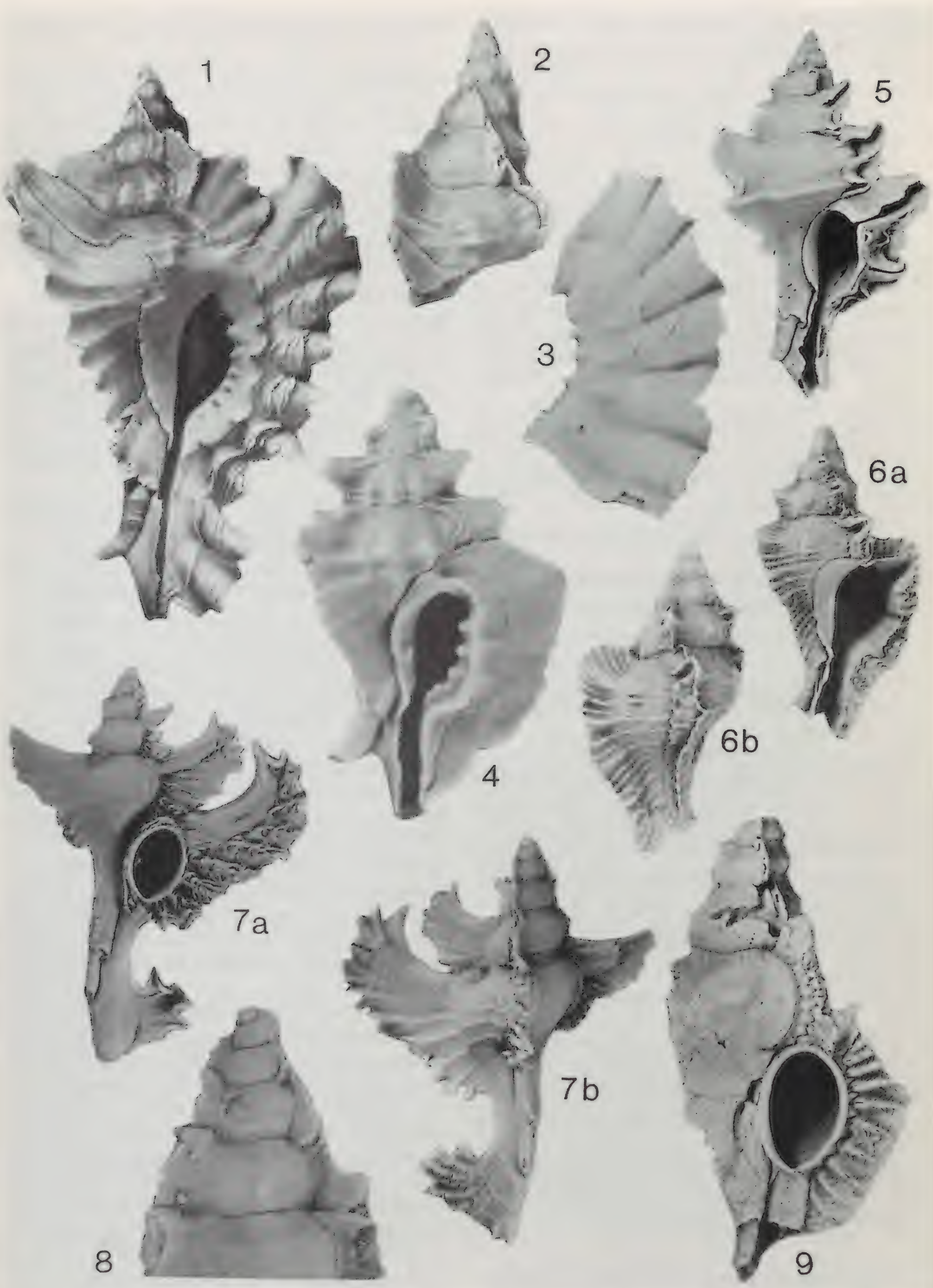


PLATE 4

Discussion: Pterochelus is another group that has existed since the Paleogene with little change. There is some doubt about whether the group is still living in the Western Atlantic, but certainly there is no question about the Oligocene species.

Pterynotus (Pterochelus) angelus (Aldrich)
Plate 4, figure 5

Pterynotus (Pterochelus) angelus (Aldrich). VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 15, pl. 3, fig. 5 (holotype); MACNEIL and DOCKERY, 1984, Mississippi Bur. Geol., Bull. 124, p. 125, pl. 5, figs. 3 (holotype), 4, 5.

Holotype: USNM 644608; height 26 mm, diameter 14 mm.

Type locality: Red Bluff Formation; Red Bluff, Chickasawhay River, Wayne County, Mississippi (= TU 1288).

Occurrence: Red Bluff Formation, Mississippi.

Figured specimen: USNM 644608 (holotype).

Discussion: MacNeil and Dockery (1984, p. 126-127) discussed this "orphan species" that is most closely related to the European *P.(P.) bispinosus* (J. de C. Sowerby, 1823), and concluded that there is nothing resembling it in the older Eocene beds or the Oligocene beds in the Gulf Coast region. I now have had the opportunity to compare the American species with several examples of the European one and the only difference I can discern is that the European specimens have a higher spire, making the shell appear more elongate. If the two forms occurred together, the differences would be considered within the limits of species variability.

When I discussed this species in 1970, I noted only three poor examples in the collections of the U.S. National Museum; MacNeil and Dockery (1984, pl. 5, figs. 3-5) have figured all three of these specimens. They had little new material and we have none. Thus, my original statement about hesitating to place the American and European species in synonymy without more material remains unchanged.

Pterynotus (Pterochelus) ariomus (Clench and Pérez Farfante)
Plate 4, figure 6

Pterynotus (Pterochelus) ariomus (Clench and Pérez Farfante). VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 15.

Pterochelus ariomus (Clench and Pérez Farfante). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 96, text-fig. 59 (after holotype); FAIR, 1976, The Murex Book, p. 22, pl. 14, fig. 187 (holotype); ABBOTT and DANCE, 1982, Compendium of Seashells, p. 141 (holotype, color photograph); VOKES, 1989, American Conchologist, v. 17, no. 2, p. 5, fig. 10 (holotype).

?Synonym:

Murex helenae VERRILL, 1953, Mins. Conch. Club So. California, no. 132, p. 10, text-figs.; FAIR, 1976, The Murex Book, p. 47.

Pterochelus helenae (Verrill). VOKES, 1989, American Conchologist, v. 17, no. 2, p. 5, fig. 11 (after Verrill).

Holotype: MCZ 164734; height 24 mm, diameter 12.5 mm.

Type locality: Off Hollywood, Florida, in 50-60 fathoms [91-109 meters].

Occurrence: Recent only, Florida to (?)Montserrat, Lesser Antilles.

Figured specimen: MCZ 164734 (holotype).

Discussion: In a paper (Vokes, 1989a) on the distribution (primarily Australian) of the living species of *Pterochelus,* I discussed the problem of the western Atlantic species. The fact that the holotype of *P. ariomus* has remained unique for 50 years does cause one to doubt its validity. But there are three mitigating factors: (1) the holotype was collected alive, (presumably) off Florida; (2) there is a markedly similar species in the Pliocene of England, *P. elegantula* (Harmer, 1918, p. 340, pl. 35, fig. 20); and (3) two additional specimens, named *Murex helenae* by Verrill, (supposedly) were collected in fish-traps off Montserrat.

Of course, it is possible that the locality for the holotype of *P. ariomus* is wrong and it came from Australia. It seems quite probable that the Verrill specimens are actually battered examples of the Australian species *P. triformis* (Reeve, 1845), as they appear to be. But this does not explain the presence of the species in the Pliocene of England. And, if the genus was still present in the eastern Atlantic as late as Pliocene time, why should it not still be living somewhere in the western Atlantic? Only discovery of additional material will give a final answer.

Subgenus PURPURELLUS Jousseaume, 1880

Purpurellus JOUSSEAUME, 1880, Le Naturaliste, Année 2, no. 42, p. 335.

Type species: *Murex gambiensis* Reeve, 1845, by original designation.

Discussion: It has been suggested that the morphologic differences between *Purpurellus* and *Pterynotus* are such as to warrant their separation into distinct genera. This has some merit, as the presence of a sealed siphonal canal is extremely rare in the subfamily Muricinae and certainly is of great taxonomic significance. To me, the varical formation and the ornamentation on the early teleoconch whorls (see pl. 4, fig. 8) are so similar to *Pterynotus* s.s. as to outweigh the sealed canal for distinction. However, this is a personal opinion.

PTERYNOTUS (PURPURELLUS) REPETITI Vokes
Plate 4, figure 9

Pterynotus (Purpurellus) repetiti VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 16, pl. 3, fig. 4.

Holotype: USNM 646438; height (incomplete) 53.5 mm, diameter 28 mm.

Type locality: TU 866, "Silverdale Beds"; marl pit on north side of Webb Creek and east of unnumbered county highway, Silverdale, Onslow County, North Carolina.

Occurrence: "Silverdale Beds" (= Silverdale Formation, = Haywood Landing Member, Belgrade Formation), North Carolina.

Figured specimen: USNM 646438 (holotype).

Discussion: The beds at Silverdale, from which the original type lot of only three specimens was collected, initially were considered to be part of the Trent Limestone. When certain muricid species were described from the Silverdale beds (Vokes, 1963, p. 161) and when I treated *Chicoreus (Phyllonotus) davisi* (Richards, 1943) (Vokes, 1967, p. 140) the question of the correct name for the formation was raised. In 1978, two different papers appeared on the Tertiary stratigraphy of North Carolina. One of these (Baum *et al.*, 1978) used the names Belgrade Formation and Silverdale Formation for the two "geographically isolated and lithologically dissimilar units." At about the same time, Ward *et al.* (1978, p. F15) proposed the Haywood Landing Member of the Belgrade Formation for the beds exposed at Haywood Landing and Silverdale. Although the name "Silverdale" has priority on the basis of my informal usage, Baum *et al.* have noted that there are no natural outcrops of either the Belgrade or the Silverdale formations, only exposures in working quarries. A legitimate type locality at Hayward Landing supports the adoption of the latter name (especially as it was proposed by members of the U.S. Geological Survey).

Regardless of the name, the beds, formerly considered to be of Early Miocene age, have been placed in the Late Oligocene (Chickasawhayan Stage) by Gibson (1977, p. 202; 1983, p. 38). Otherwise, there is no new information on this earliest known species of *Purpurellus*. Originally it was the sole link in the otherwise disjunct distribution of a group that today occurs only in West Africa (*P. gambiensis*, the type species) and West America (*P. pinniger* and *P. macleani*). But, now a second species has been reported from the Gurabo Formation of the Dominican Republic.

PTERYNOTUS (PURPURELLUS) MIRIFICUS Vokes
Plate 4, figures 7, 8

Pterynotus (Purpurellus) mirificus VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 54, pl. 5, figs. 10, 12.

Holotype: USNM 323885; height 29.6 mm, diameter 17.6 mm.

Type locality: TU 1215, Gurabo Formation; Río Gurabo, bluffs on both sides from the ford on the Los Quemados-Sabaneta road upstream to approximately 1 km above the ford, Dominican Republic.

Occurrence: Gurabo Formation, Dominican Republic.

Figured specimens: Fig. 7, USNM 323885 (holotype). Fig. 8, USNM 323884 (paratype B); height (incomplete) 13.5 mm, diameter (incomplete) 11.9 mm; locality TU 1215. Additional locality: TU 1227A.

Discussion: This exquisite little species, which resembles a miniature *P. gambiensis*, is common in the Gurabo Formation, there being 85 specimens in the type lot. But almost all are from a single locality, which is a coral-reef. However, none of the living species are known to inhabit coral-reefs today.

McClincy (1991, p. 45) has described the habitat of the Recent Panamic representatives of the genus, *P. pinniger* (Broderip, 1833) and *P. macleani* Emerson and D'Attilio, 1969. He observed that *P. pinniger* is found "in sand between small rocks on a rubble bottom" but *P. macleani* hides in crevices in rock cliffs, both at about the same 18-20 meters depth.

The West African *P. gambiensis* probably occupies the same niche as *P. pinniger,* as it is usually taken in fishermen's nets. Presumably the Gurabo *P. mirificus* inhabited an environment most similar to that of *P. macleani,* except that the cliff was coral and not ordinary rock.

Genus POIRIERIA Jousseaume, 1880
Subgenus POIRIERIA s.s.

Poirieria JOUSSEAUME, 1880, Le Naturaliste, Année 2, no. 42, p. 335.

Type species: *Murex zelandicus* Quoy and Gaimard, 1833, by original designation.

Discussion: When Part V of Cenozoic Muricidae (including the genus *Poirieria*) was published (Vokes, 1970), the earliest known species of the typical subgenus was *P. woodsensis* from the Early Eocene of Alabama. That paper was published in June; in July, I collected a broken but unmistakable specimen of true *Poirieria* in the Paleocene Matthews Landing Marl at Kimbrough, Alabama (see pl. 5, fig. 1). This same species subsequently was figured by Toulmin (1977, pl. 7, fig. 10, as "*Eupleura morula*"). Thus, representatives of three different muricine generic taxa – *Pterynotus* s.s., *Poirieria* s.s., and *Poirier-*

PLATE 5

Figures Page

1, 2. *Poirieria (Poirieria)* species (X 2) 24
1. USNM 462677; height (as is) 15 mm; diameter (as is) 15 mm.
Locality: TU 735, Alabama; Matthews Landing Marl Member, Porters Creek Formation.
2. GSA 160-2; height 23.3 mm, diameter (including spines) 15.3 mm.
Locality: Matthews Landing, Alabama River, Wilcox County, Alabama; Matthews Landing Marl Member, Porters Creek Formation.

3. *Poirieria (Poirieria) woodsensis* Vokes (X 2) 24
ANSP 7059 (holotype); height 23 mm, diameter (including spines) 16 mm.
Locality: Woods Bluff, Tombigbee River, Clarke County, Alabama; Bashi Marl Member, Hatchetigbee Formation.

4. *Poirieria (Poirieria) actinophora* (Dall) (X 2 1/2) 25
USNM 430478; height 20.6 mm, diameter (including spines) 14.3 mm.
Locality: U.S. Virgin Islands; Recent.

5. *Poirieria (Paziella) cretacea* Garvie (X 3) 26
USNM 455526 (holotype); height 16.5 mm, diameter 10.1 mm.
Locality: Colorado River, bluff on left bank at Webberville, Travis County, Texas; Kemp Clay.

6, 7. *Poirieria (Paziella) harrisi* Vokes (X 3) 28
6. ANSP 14225 (holotype); height 15 mm, diameter (including spines) 11 mm.
Locality: Matthews Landing, Alabama River, Wilcox County, Alabama; Matthews Landing Marl Member, Porters Creek Formation.
7. USNM 462678; height 16.1 mm, diameter (including spines) 11.8 mm.
Locality: Alabama River, at Dixon's Creek, Wilcox County, Alabama; Matthews Landing Marl Member, Porters Creek Formation.

8. (?)*Poirieria (Paziella) progne* White (X 2) 29
MNRJ 2 972-I (holotype); height 26 mm, diameter 18 mm (after White, 1887, pl. 11, fig. 14).
Locality: Rio Maria Farinha, Pernambuco, Brazil; Maria Farinha Formation.

9. *Poirieria (Paziella) septima* Vokes (X 1 1/2) 30
USNM 646429 (holotype); height 33 mm, diameter 17 mm.
Locality: USGS 10631, Tuzendepetl [*i.e.*, Tuzantepetl], Río Coatzacoalcos, Veracruz, Mexico; Concepcion Inferior Formation.

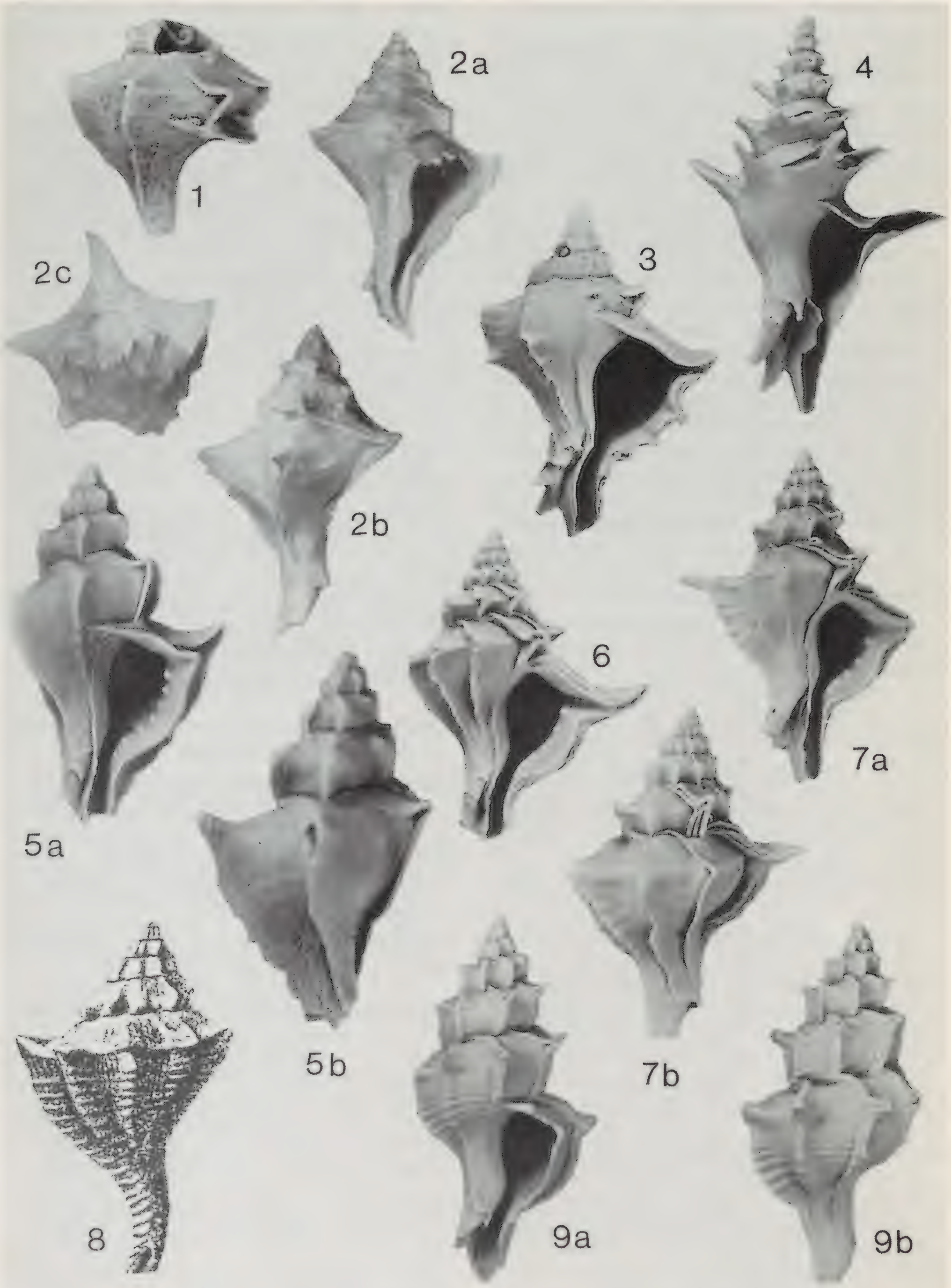


PLATE 5

ia (Paziella) – are now known from the earliest Tertiary.

Formerly, there was considered to be a single Recent species of *Poirieria* s.s. in the western Atlantic, the bizarre South Atlantic form named as *Murex clenchi* Carcelles, 1953. Rios (1975, p. 104, pl. 30, fig. 441; 1985, p. 87, pl. 31, fig. 388) placed *M. clenchi* in the synonymy of *Trophon acanthodes* Watson, 1883, noting that *M. clenchi* is an "anomalous specimen." This is reasonable, given the large size (height 51 mm) of *M. clenchi,* for *T. acanthodes* is by far the largest known species of "*Trophon.*" The type is only 37 mm in height but there are many specimens in the collections of the Museo Argentino de Ciencias Naturales "Bernardino Rivadavia" in Buenos Aires that exceed 100 mm. "*Trophon*" *acanthodes* is a common species in the deeper water off Argentina and is collected in large numbers by fishermen. The generic placement of the species remains open but it belongs to the group of *Trophon* s.l., and not to *Poiriera.*

However, another Recent species of *Poirieria* does occur in the Atlantic Ocean. As discussed elsewhere (Vokes, 1988, p. 30) the deep-water species "*Trophon*" *actinophorus* Dall, 1889, has been shown by Bayer (1971, p. 157) to be a member of the genus *Poirieria.* The subgenus *Poirieria* s.s. is another line that is present in the Paleogene and then does not reappear until the Recent fauna due to having moved into a deeper habitat (on average 440 meters for *P. actinophora,* Bayer, 1971, p. 159).

Merle (1989, p. 152) erected a new genus *Crassimurex* (type species *Murex calcitrapoides* Lamarck, 1803). This taxon differs from *Poirieria* s.s. by having more developed spiral sculpture and a "squattier" ("plus trapue") shape due to the lower spire; however, I would consider *Crassimurex* to be no more than a subgenus of *Poirieria. Murex calcitrapoides* does indeed have more strongly developed spiral sculpture than the typical smooth *Poirieria zelandica,* but my opinion is that the differences are minor and are specific rather than generic.

POIRIERIA (POIRIERIA) species
Plate 5, figures 1, 2

Eupleura morula (Conrad). TOULMIN, 1977, Geol. Surv. Alabama, Mon. 13, p. 160 (in part, not of Conrad), pl. 7, fig. 10.

Occurrence: Matthews Landing Marl Member, Porters Creek Formation, Alabama.

Figured specimens: Fig. 1, USNM 462677; height (as is) 15 mm; diameter (as is) 15 mm; locality TU 735. Fig. 2, Alabama Geological Survey, GSA 160-2; height 23.3 mm, diameter (including spines) 15.3 mm; locality, Matthews Landing, Alabama River, Wilcox County, Alabama.

Discussion: From the Paleocene beds of Alabama there are two incomplete specimens of an undescribed species of *Poirieria* s.s. This species differs from both the European Eocene *P.(P.) subcristatus* (d'Orbigny, 1850) and the American Eocene *P.(P.) woodsensis,* as well as the living *P.(P.) zelandica* (type of the genus), in lacking secondary spines anterior to the shoulder. In this aspect it is similar to the Recent *P.(P.) actinophora,* but differs from the latter in having a broader shell with a much lower spire. As both of the known examples are badly broken, the species will not be described at this time, but the presence of this oldest known occurrence of *Poirieria* s.s. is documented here.

POIRIERIA (POIRIERIA) WOODSENSIS Vokes
Plate 5, figure 3

Poirieria (Poirieria) woodsensis VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 17, pl. 4, figs. 1, 2.

Eupleura morula (Conrad). TOULMIN, 1977, Geol. Surv. Alabama, Mon. 13, p. 160 (in part, not of Conrad; not pl. 7, fig 10 = *Poirieria* sp.).

Crassimurex woodsensis (Vokes). MERLE, 1989, Bull. Mus. Natl. Hist. Nat. Paris, v. 11, Sect. C, no. 3, p. 152.

Holotype: ANSP 7059; height 23 mm, diameter (including spines) 16 mm.

Type locality: Bashi Marl Member, Hatchetigbee Formation; Woods Bluff, Tombigbee River, Clarke County, Alabama.

Occurrence: Bashi Marl Member, Hatchetigbee Formation, Alabama.

Figured specimen: ANSP 7059 (holotype).

Discussion: Toulmin (1977, p. 160) perpetuated the confusion of the reported occurrence of "*Murex morulus* Conrad" at both Matthews Landing (Paleocene) and Woods Bluff (Early Eocene). The species from Woods Bluff is not the same as the one named *M. morulus* by Conrad (see *P.*

harrisi Vokes, below), which does occur at Matthews Landing; in fact, it is not even the same subgenus. Therefore, it was designated *P. woodsensis*.

As Toulmin (1977, p. 370) noted, Woods Bluff formerly exposed several fossiliferous beds but is now covered by backwater from Coffeeville Dam, yet another victim of improved river navigation.

Merle (1989, p. 152) placed *P. woodsensis* into his new genus *Crassimurex* (type species: *Murex calcitrapoides* Lamarck, 1822; unnecessary new name for *Murex calcitrapa* Lamarck, 1803, not *M. calcitrapa* Lamarck, 1822), a move I find impossible to accept. The only differences between *P. woodsensis* and *P. zelandica* are the lower spire and shorter spines in the older species. There is no more spiral ornamentation in *P. woodsensis* than in *P. zelandica*.

Poirieria (Poirieria) actinophora (Dall)
Plate 5, figure 4

Trophon (Boreotrophon) actinophorus DALL, 1889, Harvard Mus. Comp. Zool., Bull, v. 18, p. 206, pl. 16, fig. 2; DALL, 1889, U.S. Natl. Mus., Bull. 37, p. 20, pl. 15, fig. 2 (entire plate is copy of previous); M. SMITH, 1953, Illus. Cat. Recent Species Rock Shells, p. 19, pl. 9, fig. 2 (after Dall).

Boreotrophon (Actinotrophon) actinophorus (Dall). DALL, 1902, U.S. Natl. Mus., Proc., v. 24, p. 534.

"Unnamed." OLSSON, 1964, Neogene Moll. Northwest. Ecuador, pl. 20, fig. 5 (not in text).

Trophon actinophorus Dall. BULLIS, 1964, Tulane Stud. Zoology, v. 11, p. 107; RIOS, 1975, Brazilian Marine Moll. Icon., p. 88, pl. 25, fig. 361 (after Dall).

Murex (Paziella) actinophorus (Dall). BAYER, 1971, Bull. Marine Sci., v. 21, no. 1, p. 157, text-figs. 30, 35D (radula).

Poirieria (Paziella) actinophorus (Dall). ABBOTT, 1974, American Seashells, ed. 2, p. 186.

Actinotrophon actinophorus (Dall). ABBOTT, 1974, American Seashells, ed. 2, p. 191, fig. 210; RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 176, text-fig. 116 (after Dall); D'ATTILIO, 1980, Festivus, v. 12, no. 4, p. 61, fig. 1.

Poirieria (Poirieria) actinophorus (Dall). RIOS, 1985, Seashells of Brazil, p. 83, pl. 29, fig. 361 (after Dall).

Poirieria (Poirieria) actinophora (Dall). VOKES, 1988, Tulane Stud. Geol. Paleont., v. 21, no. 1, p. 29, pl. 4, figs. 3-5.

Holotype: MCZ 7371; height 17.5 mm, diameter (including spines) 14 mm.

Type locality: *Blake* Station 143, off Santa Cruz (St. Croix, V.I.), in 248 fathoms [454 meters].

Occurrence: Esmeraldas beds, Ecuador. Recent, western Atlantic from Bahama Islands to Brazil, Panama, and Colombia (Bayer, 1971, p. 159).

Figured specimen: USNM 430478; height 20.6 mm, diameter (including spines) 14.3 mm; locality, U.S. Virgin Islands. Additional locality: TU 1397.

Discussion: In a work on the fauna of the Pliocene Esmeraldas beds, Onzole Formation, of northwestern Ecuador (Vokes, 1988, p. 30) I noted that *P. actinophora* is one of the few muricine species occurring in both the Atlantic and Pacific faunas. But given the extreme conservatism of the group and its world-wide distribution since the Eocene, its presence in the eastern Pacific is noteworthy but not totally unexpected.

Subgenus PAZIELLA Jousseaume, 1880

Paziella JOUSSEAUME, 1880, Le Naturaliste, Année 2, no 42, p. 335.

Type species: *Murex pazi* Crosse, 1869, by original designation.

Discussion: Paziella is the earliest genus-group of Muricinae, and the only one known older than the Paleocene. Until recently, only a single small specimen (*ca.* 8 mm) represented the Muricinae prior to the Tertiary. This species from the Cenomanian of Saxony, eastern Germany, was named *Murex armatus* Geinitz, 1874. That name is preoccupied by *M. armatus* A. Adams, 1854, and Garvie (1991, p. 88) has renamed it *Poirieria (?Paziella) cenomae*. This species is still the oldest known species of Muricinae but no longer the only pre-Tertiary representative, as Garvie has discovered a second Cretaceous species from the Kemp Clay (Maastrictian) of Texas.

According to Merle (1989, p. 151) the lower spire and the absence of spines on the base of the canal forbids ("empechent") placement of the early species that I would refer to *Paziella* in that group and he would place them in the subgenus *Flexopteron*. There are several species of *Paziella*, both fossil and Recent, which

lack spines on the siphonal canal. For these the subgenus *Bathymurex* Clench and Pérez Farfante, 1945 (type species: *Murex atlantis* Clench and Pérez Farfante; see pl. 5, fig. 11) is available.

However, there are greater differences than just the spire and the spines between *Paziella* and *Flexopteron*. The genus *Flexopteron* (type species: *F. philippinensis* Shuto) is characterized by foliaceus varices, each with a slight shoulder spine formed by the folding over of the varical flange. The aperture is denticulate and patulous. The siphonal canal is short and broad. The only resemblance between *Flexopteron* and those species that Merle would include is the patulous aperture and the folding over of the posterior edge of the apertural flange. In this respect, these species do resemble *Flexopteron* (see *P. collata* below, pl. 6, figs. 5, 6), but the unflanged varices and the narrow extended siphonal canal are much more like *Paziella*. It is probable that the line of *Flexopteron* is derived from these early species of *Paziella*, and similarities should be expected.

The living species *P.(P.) petuchi*, n. sp., *P.(P.) galapagana* (Emerson and D'Attilio, 1970), and presumably *P.(P.) atlantis* (Clench and Pérez Farfante, 1945), differ from the other members of *Paziella* in their relatively heavy intritacalx, or chalky outer layer. Thus, the subgenus *Bathymurex* may be a distinct taxon, including those species similar to *Paziella* but lacking the spines encircling the siphonal canal. Other than the intritacalx, the minimal differences between these species do not warrent the change. However, to keep the most similar species together, they will be divided into Species Groups as above.

Species Group 1: *Poirieria (Paziella) harrisi*

Discussion: There is no evidence that the earliest species of *Paziella* possessed the thick intritacalx seen in the later ones here referred to the group of *P.(P.) atlantis*. This may be an artifact of preservation but, generally at least remnant patchs remain on most specimens, if originally present, and none of the many specimens of *P. harrisi* show such traces.

POIRIERIA (PAZIELLA) CRETACEA Garvie
Plate 5, figure 5

Poirieria (Paziella) cretacea GARVIE, 1991, Tulane Stud. Geol. Paleont., v. 24, no. 4, p. 87, pl. 1, figs. 1, 2.

Holotype: USNM 455526; height 16.5 mm, diameter 10.1 mm.

Type locality: Kemp Clay; Colorado River, bluff on left bank at Webberville, Travis County, Texas.

PLATE 6

Figures Page

1. *Poirieria (Paziella) dominicensis* (Gabb) (X 2 1/2) 29
   USNM 323882; height 18.7 mm, diameter (excluding spines) 10.8 mm.
   Locality: TU 1227, Dominican Republic; Gurabo Formation.
2. *Poirieria (Paziella) atlantis* (Clench and Pérez Farfante) (X 2 1/2) 32
   MCZ 164684 (holotype); height 23.5 mm, diameter (excluding spines) 10.5 mm.
   Locality: *Atlantis* Station 3333, Bahía de Cochinos, Santa Clara Province, Cuba, in 190 to 200 fathoms [348 to 366 meters]; Recent.
3, 4. *Poirieria (Paziella) petuchi* Vokes, n. sp. (X 2 1/2) 32
   3. USNM 784571; height 26 mm, diameter 16.6 mm.
   Locality: Golfo de Triste [northwest of Puerto Cabello], Venezuela, in 35 meters (by shrimpers); Recent.
   (Photograph courtesy of S.D. Kaicher)
   4. (4c X 10) Sunderland Coll. (paratype A), height 26.3 mm, diameter 16.6 mm.
   Locality: Golfo de Venezuela, in 200 meters (by shrimpers); Recent.
5, 6. *Poirieria (Flexopteron) collata* (Guppy) (X 2 1/2) 35
   5. USNM 323881; height 20.8 mm, diameter 14.2 mm.
   Locality: TU 1227, Dominican Republic; Gurabo Formation.
   6. USNM 462679; height (incomplete) 17 mm, diameter 12.8 mm.
   Locality: TU 1227, Dominican Republic; Gurabo Formation.

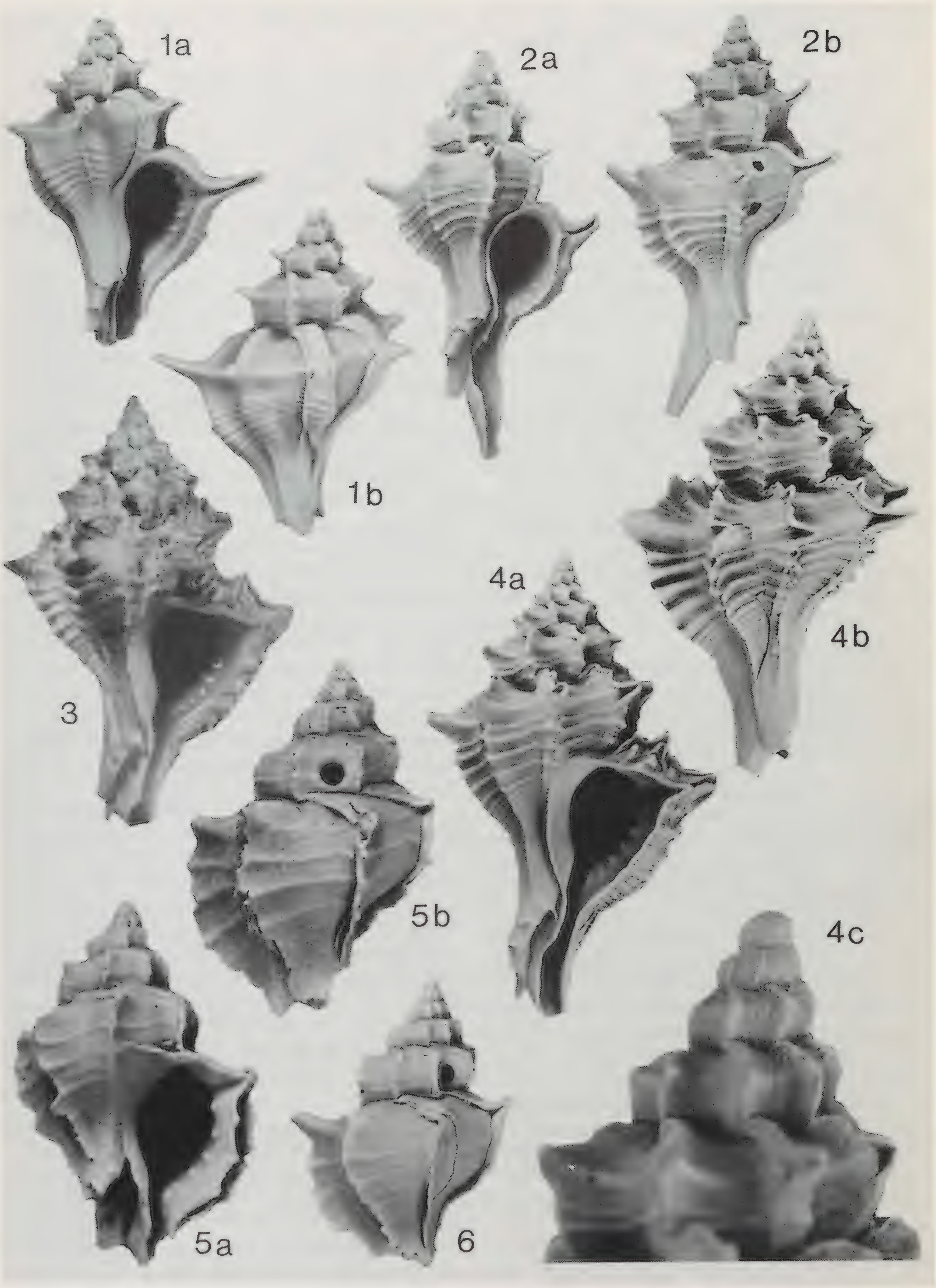


PLATE 6

Occurrence: Kemp Clay, Texas.
Figured specimen: USNM 455526 (holotype).

Discussion: A most exciting find is the recent discovery of a new species referable to the subgenus *Paziella* in the Maastrictian beds of eastern Texas. Not surprisingly, given the conservatism of the group and the close geologic age, there is a great similarity between this latest Cretaceous species and the earliest Tertiary *P. harrisi* Vokes. The only differences are the fewer and less foliated varices, and the smoother surface ornamentation in the older species.

POIRIERIA (PAZIELLA) HARRISI Vokes
Plate 5, figures 6, 7

Poirieria (Paziella) harrisi VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 18, pl. 4, fig. 3 (new name for *Murex morulus* Conrad, 1860, *non* Schroter, 1805).
Eupleura morula (Conrad). TOULMIN, 1977, Geol. Surv. Alabama, Mon. 13, p. 160 (in part, not pl. 7, fig. 10 = *Poirieria* sp.).
Poirieria (Flexopteron) septemcostata harrisi (Vokes). MERLE, 1989, Bull. Mus. Natl. Hist. Nat. Paris, (Ser. 4) v. 11, Sect. C, no. 3, p. 151.

Holotype: ANSP 14225; height 15 mm, diameter (including spines) 11 mm.

Type locality: Matthews Landing Marl Member, Porters Creek Formation; Matthews Landing, Alabama River, Wilcox County, Alabama.

Occurrence: Matthews Landing Marl Member, Porters Creek Formation, Alabama.

Figured specimens: Fig. 6, ANSP 14225 (holotype). Fig. 7, USNM 462678; height 16.1 mm, diameter (including spines) 11.8 mm; locality, Alabama River, at Dixon's Creek, Wilcox County, Alabama.

Discussion: As observed previously (Vokes, 1970, p. 19), this small species is not rare. For example, David T. Dockery III obtained over 75, mostly juvenile, specimens from a site on the Alabama River about one mile below the type locality at Matthews Landing.

From these beautifully preserved juvenile shells it can be seen that the species has a primitive four whorl conical protoconch. Beginning at the terminal varix of the protoconch there are about nine varices on each whorl of the teleoconch, each formed by a simple flange of shelly material. On the later whorls, periodically one varix is thickened and presumably labral denticles are formed; but only those at the aperture are visible. The other varices remain as a thin single layer of shell. There is no pattern to these thickened varices; there may be one or several on a whorl. If two are thickened, one on either side, there is a strong resemblance to the genus *Eupleura,* which caused Palmer and Brann (1966, p. 669) to refer the species to this only distantly related ocenebrine genus.

Also, one can see how the animal might develop consistently three thickened varices per whorl and become a *Pterynotus*. Other than having seven rather than nine varices on the first two teleoconch whorls, the juveniles of the contemporary *Pterynotus matthewsensis* are virtually identical. The protoconchs of the two species are similar, with four conical whorls on each, but that of *Pterynotus matthewsensis* is almost twice as large (0.8 mm *vs.* 0.4 mm in diameter) as that of *P. harrisi*.

In the plate explanation for this species previously (Vokes, 1970, pl. 4), I mistakenly cited the locality for the figured specimen as "Claiborne Bluff, Alabama River, Alabama. Gosport Sand, middle Eocene." Obviously, as the figured specimen is the holotype of *Murex morulus* Conrad, the specimen came from Matthews Landing not Claiborne Bluff! I apologize for this *lapsus*.

Unfortunately, my mistake caused Merle (1989, p. 151) to cite *P. harrisi* as from the Claibornian of Mississippi [*sic*]. This is one of the species that he would place in the subgenus *Flexopteron*. Certainly there are similarities, but I believe that the greater affinity is with *Paziella* and not *Flexopteron*. Likewise, there is a strong generic similarity between *P. septemcostata* (Roualt, 1850) (see Merle, 1989, p. 2, figs. 8, 9) and *P. harrisi,* but not enough to consider the latter a subspecies of the former.

Toulmin (1977, p. 160) reported this species from both Matthews Landing and Woods Bluff, but this is due to confusion with *P. woodsensis* (above). His figured specimen, however, is neither *P. harrisi* nor *P. woodsensis,* but is an undescribed species cited above as *Poirieria (Poirieria)* species.

Species Group 2: *Poirieria (Paziella) atlantis*

(?) POIRIERIA (PAZIELLA) PROGNE (White)
Plate 5, figure 8

Trophon progne WHITE, 1887, Archiv. Mus. Nac. Rio de Janeiro, v. 7, p. 139, pl. 11, fig. 14; PENNA, 1965, Pap. Avul., Dept. Zool., Sao Paulo, v. 17, art. 21, p. 272.

Not *Trophon progone*? White. MAURY, 1912, Acad. Nat. Sci. Philadelphia, Jour., (Ser. 2) v. 15, p. 81, pl. 11, figs. 7, 8.

Holotype: MNRJ 2 972-I; height 26 mm, diameter 18 mm (*fide* White, 1887).

Type locality: Maria Farinha Formation; Rio Maria Farinha, Pernambuco, Brazil.

Occurrence: Maria Farinha Formation, Brazil.

Figured specimen: Holotype, after White, 1887, pl. 11, fig. 14.

Discussion: White described this species from the Paleocene Maria Farinha Formation of Brazil on the basis of a "gutta percha cast of a natural mould, and a natural cast of the interior of the same example" (1887, p. 140). The Museu Nacional de Rio de Janeiro was unable to provide a casting of this species, named as a *Trophon*, but from White's illustration (reproduced here, pl. 5, fig. 8) it is more likely a *Paziella* than a *Trophon*. It is similar to the contemporary *P. harrisi* but has numerous spiral threads on the body whorl. In this it resembles the younger *P. dominicensis* (Gabb) and, for this reason, is placed in this Species Group.

Maury (1912, p. 81, pl. 11, figs. 7, 8) tentatively attributed two fragments from the Paleocene of Soldado Rock, Trinidad, to this species. But her illustrations show neither the varical ridges nor the spiral cords. Other than similar age there is little reason to consider them the same.

POIRIERIA (PAZIELLA) DOMINICENSIS (Gabb)
Plate 6, figure 1

Poirieria (Paziella) dominicensis (Gabb). VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 19, pl. 4, fig. 4 (lectotype); VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 55, pl. 5, fig. 7.

Synonym:

Murex (Trophon) werneri TOULA, 1911, K.-K. Geol. Reichsanst., Jahrb., v. 61, p. 479, pl. 29, fig. 9.

Lectotype: ANSP 3252 (selected by Pilsbry, 1922, p. 354); height 17.5 mm, diameter (including spines) 11 mm.

Type locality: TU 1227, Gurabo Formation; Arroyo Zalaya, which crosses the road to Jánico from Santiago de los Caballeros, 11 km south of the bridge over the Río Yaque del Norte, at Santiago, Dominican Republic (restricted by Vokes, 1989b, p. 56).

Occurrence: Gurabo Formation, Dominican Republic; Concepcion Inferior Formation, Mexico.

Figured specimen: USNM 323882; height 18.7 mm, diameter (excluding spines) 10.8 mm; locality TU 1227. Additional localities: TU 1251, 1292, 1353, 1448, 1452.

Discussion: Our work in the Dominican Republic showed that *P.(P.) dominicensis* is not rare there, but it is confined to the deepest water portions of the Gurabo Formation in the vicinity of Santiago de los Caballeros. Thus, it was not taken by either the Maury party (Maury, 1917) or the USGS team (Vaughan *et al.*, 1921), who made collections only in the more western, shallower portions of the section.

The specimen I cited from the U. S. National Museum collection (Vokes, 1970, p. 20), is said to be from USGS locality 8516 (= TU 1219) at Potrero [not Portero, as stated], but as discussed in my Dominican report (Vokes, 1989b, p. 56), this probably is incorrect. The specimen came from a collection made by Bland in which the localities are badly confused. Most specimens said to be from Potrero (which is in the Gurabo Formation) appear to be from the Baitoa Formation. But, for *P. dominicensis* the specimen is from neither Potrero nor the Baitoa formation, and its actual source is not known.

The Mexican species *Murex werneri* Toula, 1911, was described from km 70, on the Trans-Isthmian Railroad. In 1970 I said that the beds exposed at this locality probably were the Paraje Solo Formation. Since then we have collected at km 70 (TU 1321) and, although there are no aragonitic shells remaining, the calcareous microfossils indicate an age of N.20 (Akers, 1981, p. 146 [more likely N.19, Kohl, 1985, fig. 7]) and are presumed to be the Concepcion Inferior Formation, the deeper water facies of the sequence of "formations" present in the Isthmus of Tehuantepec, deposited in depths of 180-200 meters (Kohl, 1985, p. 25). The Paraje Solo Formation (to

which I questionably assigned the species) is very shallow, with lignite layers, indicating fresh-water deposition; clearly this deep-water mollusk did not live in that environment.

I also reported a maximum size of 30 mm for the species, based upon Toula's statement (1911, p. 479) that his holotype was 30 mm in height. The largest of the Dominican specimens measures only 21 mm, and reexamination of Toula's work shows that the holotype of *Murex werneri* is only 25 mm in height.

On the basis of the original illustration, another species, *Murex eliseoduartei* Figueiras and Broggi (1976, pl. 1, fig. 3), described from the Late Miocene Camacho Formation of Uruguay, has a marked resemblance to *P. dominicensis*. However, examination of a latex cast made from the original mold (kindly provided to me by Prof. Figueiras) shows that it is a species of the typhine genus *Siphonochelus (Laevityphis)*, similar to the living Caribbean *S.(L.) bullisi* Gertman, 1969. Encircling the shoulder are a series of alternating spines (at the varices) and tubes (between the varices). When the spines break off there is the appearance of eight or nine broken spines per whorl (four varices and four tubes) or, in the case of this mold of the dorsal half of the shell, five "spines."

Poirieria (Paziella) septima Vokes
Plate 5, figure 9

Poirieria (Paziella) septima VOKES, 1970, Tulane Stud. Geol. Paleont, v. 8, no. 1, p. 22, pl. 4, fig. 5.

Holotype: USNM 646429; height 33 mm, diameter 17 mm.

PLATE 7

Figures Page

1. *Poirieria (Paziella) pazi* (Crosse) (X 1 1/2) 33
   USNM 678944; height 39 mm, diameter (excluding spines) 19 mm.
   Locality: *Silver Bay* Station 2481, off Hollywood, Florida, in 200 fathoms [366 meters]; Recent.
2. *Poirieria (Paziella) nuttingi* (Dall) (X 1 1/2) 34
   USNM 869506; height 35.3 mm, diameter (excluding spines) 16.6 mm.
   Locality: West of Cape San Blas, Florida, in 200 meters; Recent.
3. *Poirieria (Paziella) oregonia* (Bullis) (X 3/4) 34
   USNM 635149 (holotype); height 85.2 mm, diameter (excluding spines) 37.8 mm.
   Locality: *Oregon* Station 2023, 95 miles [153 km] north of Pte. Mana, French Guiana, in 135 fathoms [247 meters]; Recent.
4-6. *Poirieria (Pazinotus) silvatica* (Palmer) 36
   4. (X 5) USNM 462680; height 9.6 mm, diameter 6.1 mm.
      Locality: TU 85, Mississippi; Wautubbee Formation.
   5. (X 10) USNM 462681; height 5.5 mm, diameter 3.4 mm.
      Locality: TU 1258, Texas; Weches Formation.
   6. (6a X 5; 6b X 10) USNM 638830 (holotype, *Murex angulatus* Meyer); height 9 mm, diameter 5.5 mm.
      Locality: (?) Jackson, Mississippi; (?) Moodys Branch Formation.
7, 8. *Poirieria (Pazinotus) bowdenensis* Vokes (X 4) 36
   7. USNM 869507; height 11.5 mm, diameter 6.2 mm.
      Locality: Off Cape San Blas, Florida, in 183 meters; Recent.
   8. USNM 462682; height 12 mm, diameter 6.2 mm.
      Locality: TU 1240, Costa Rica; Moín Formation.
9. *Poirieria (Pazinotus) stimpsonii* (Dall) (X 4) 37
   MCZ 7310 (paralectotype); height 11 mm, diameter 7.4 mm.
   Locality: *Blake* Station (unnumbered), off Barbados, in 100 fathoms [183 meters]; Recent.
10. *Poirieria (?Pazinotus) hystricinus* (Dall) (X 2 1/2) 37
    MCZ 7307 (lectotype); height 19.5 mm, diameter (including spines) 14.8 mm.
    Locality: *Blake* Station 206, off Martinique, Lesser Antilles, in 170 fathoms [311 meters]; Recent.

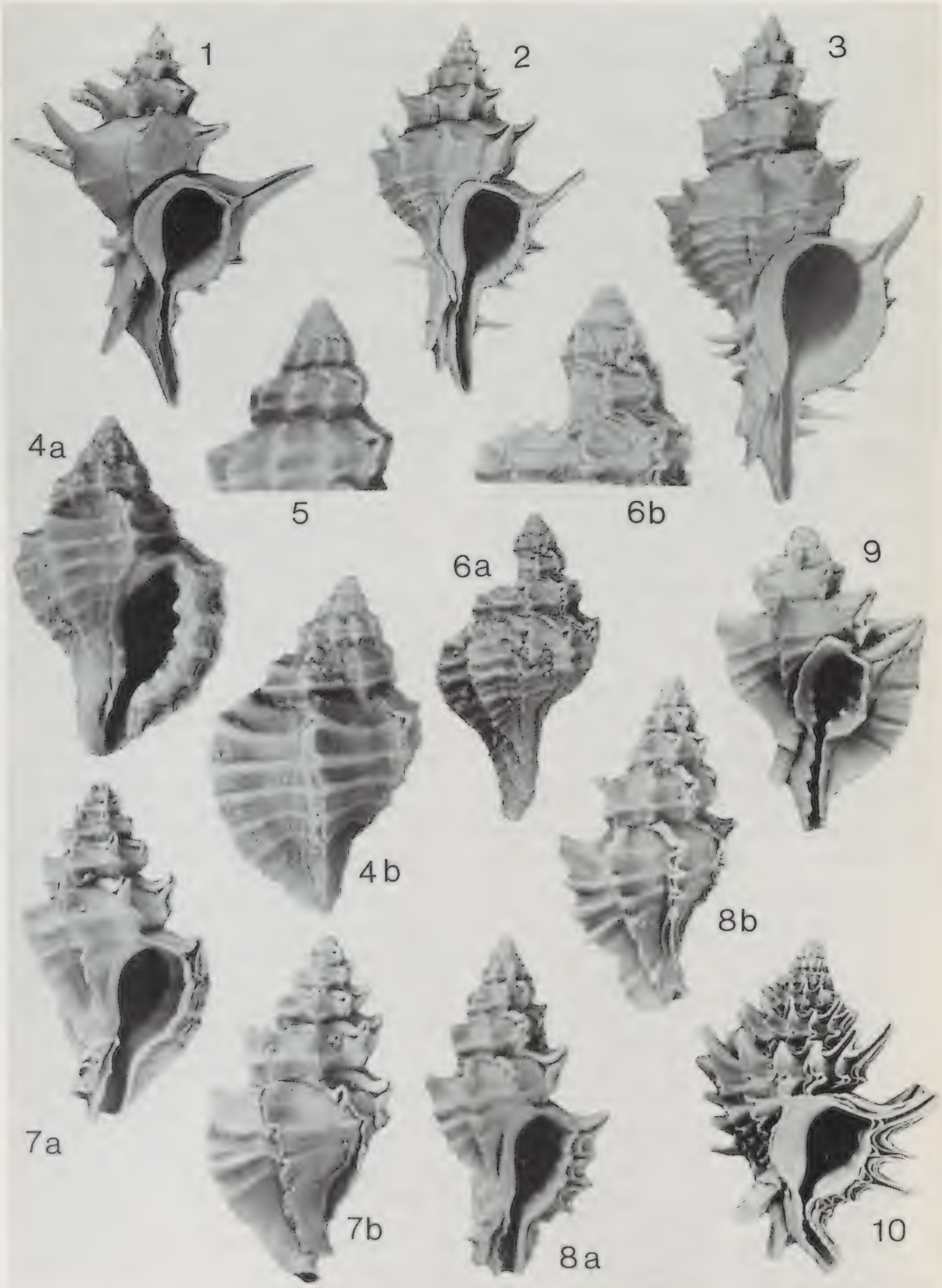


PLATE 7

Type locality: USGS 10631, Concepcion Inferior Formation; Tuzendepetl [*i.e.*, Tuzantepetl], on Río Coatzacoalcos, about seven miles [11 km] east-northeast of Minatitlan, Veracruz, Mexico.

Occurrence: Concepcion Inferior Formation, Mexico.

Figured specimen: USNM 646429 (holotype).

Discussion: Subsequent to the description of *P. septima* we located Tuzantepetl, a small village on the east bank of the Rio Coatzacoalcos, some 4 km upstream from Nanchital, or about 5 km downstream from the new bridge on Mexico Highway 180 (about 9 km above the *old* bridge at Coatzacoalcos). There is a high bluff, but the river has moved away and the material is badly weathered and overgrown. No fossils were found, but the area was originally mapped as the Concepcion Inferior Formation (R.W. Barker, personal communication, 1979), now known to be of Early Pliocene age (zone N.19, Kohl, 1985, fig. 7). As with the preceding species, this deep-water facies is more likely than the shallow-water Paraje Solo Formation to which I originally ascribed the fossil.

Poirieria (Paziella) septima differs from the other members of this Species Group in being larger (maximum height 33 mm) and having a higher spire, giving it a resemblance to the members of the group of *P. pazi,* but it lacks the spines on the siphonal canal. Intermediate species such as this one and ?*P. progone* prevent separation of these Species Groups into different subgenera.

Poirieria (Paziella) atlantis
(Clench and Pérez Farfante)
Plate 6, figure 2

Poirieria (Paziella) atlantis (Clench and Pérez Farfante). VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 23, pl. 5, fig. 2 (holotype); ABBOTT, 1974, American Seashells, ed. 2, p. 186; VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 56, pl. 5, fig. 6 (holotype).

Paziella pazi (Crosse). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 86 (in part, not of Crosse).

Paziella atlantis (Clench and Pérez Farfante). FAIR, 1976, The Murex Book, p. 22, pl. 15, fig. 196 (holotype).

Holotype: MCZ 164684; height 23.5 mm, diameter (excluding spines) 10.5 mm.

Type locality: *Atlantis* Station 3333, Bahía de Cochinos, Santa Clara Province, Cuba, in 190 to 200 fathoms [348 to 366 meters].

Occurrence: Recent only (known only from the type locality).

Figured specimen: MCZ 164684 (holotype).

Discussion: In a discussion (Vokes, 1989b, p. 56) of *P. dominicensis,* I called attention to the similarity of *P. atlantis* to the Dominican species. The only difference is that the fossil species has the spines extended almost horizontal to the axis of the shell; in *P. atlantis* they are turned more adapically, a difference similar to that between *P. pazi* (horizontal spines) and *P. nuttingi* (upturned spines).

No additional specimens of this species are known, but by analogy with the next species, which is closely related to *P.(P.) atlantis,* it is probable that the shell is covered by a thicker than usual layer of intritacalx. Traces of this intritacalx have been preserved in *P. dominicensis.*

Poirieria (Paziella) petuchi
Vokes, n. sp.
Plate 6, figures 3, 4

Panamurex gatunensis (Brown and Pilsbry). PETUCH, 1981, Malacologia, v. 22, no. 2, p. 322, figures 33, 34; PETUCH, 1987, New Caribbean Moll. Faunas, pl. 15, fig. 8 (not of Brown and Pilsbry).

Description: Biconical shell with protoconch of approximately one and one-half bulbous whorls, line of termination uncertain; teleoconch with six whorls. Axial ornamentation on first teleoconch whorl of nine small laminae, on second and all subsequent whorls, seven per whorl, gradually increasing in size to become varices. Varices formed by multiple layers of shell material, the most abapertural lamina extended as a flange, crenulated by small open spinelets at crossing of spiral cords, that at the shoulder largest, forming an open spine. Spiral ornamentation very faint, one major cord at shoulder on early teleoconch whorls, gradually adding one smaller cord between shoulder and suture and two anterior to the shoulder on spire whorls; body whorl with six major cords and numerous secondary cords between these and also on the siphonal canal. Suture deeply impressed, pits formed between varices. Aperture almost triangular, folding into the shoulder spine. Inner lip smooth, appressed at the posterior end, free-standing at the anterior end. Outer lip with seven elongate nodules, placed between the major spiral cords. Siphonal canal moderately long, slightly recurved at distal end forming weak siphonal fasciole. When fresh entire outer surface of shell covered by a thick chalky-white intritacalx masking the spiral ornamentation;

broken areas revealing tiny spiral tubes beneath the smooth external surface. Aperture pure white in color; operculum muricoid, pale yellow, with a pointed terminus similar to *Paziella pazi*.

Holotype: USNM 784571; height 26 mm, diameter 16.6 mm.

Type locality: Golfo de Triste [northwest of Puerto Cabello], Venezuela, in 35 meters (by shrimpers).

Etymology of name: In honor of Edward J. Petuch, Florida Atlantic University, Boca Raton, Florida, who first brought the little known northern South America fauna to our attention.

Occurrence: Recent only, off northern South America, Venezuela to Barbados (paratype B, off St. James, in 183 meters).

Figured specimens: Fig. 3, USNM 784571 (holotype; photograph courtesy of S.D. Kaicher). Fig. 4, Sunderland Coll. (paratype A), height 26.3 mm, diameter 16.6 mm; locality, Golfo de Venezuela, in 200 meters (by shrimpers).

Discussion: Petuch (1981, p. 322, figs. 33, 34) referred a single living specimen from off the coast of Venezuela to the fossil species *Panamurex gatunensis* (Brown and Pilsbry, 1911); however, it is not *P. gatunensis*. Nor, can it be placed in the subgenus *Panamurex*, as it lacks the columellar rugae, which distinguish *Panamurex* from *Paziella*.

Both figured specimens have been painstakingly "cleaned" and have only traces of intritacalx. Fortunately, another specimen, formerly in the collection of Eugenia Wright and now in my possession (paratype B), shows that the species has a very thick intritacalx, similar to that seen in the members of the genera *Aspella* and *Dermomurex*. This same thick intritacalx is also present in the eastern Pacific species *P.(P.) galapagana* (Emerson and D'Attilio, 1970) (see those authors, p. 272, for discussion of this layer in the paratypes).

Poirieria (Paziella) petuchi is closely related to *P.(P.) atlantis* but differs in having foliaceous varices, with small open spinelets where the spiral cords cross the varices, especially between the suture and the shoulder spine. In contrast, *P. atlantis* has rounded varical ridges, with simple welts where the spiral cords cross. The spiral cords are also heavier in *P. atlantis* than in *P. petuchi*.

Species Group 3: *Poirieria (Paziella) pazi*

POIRIERIA (PAZIELLA) PAZI (Crosse)
Plate 7, figure 1

Poirieria (Paziella) pazi (Crosse). VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 22, pl. 5, fig. 1; ABBOTT, 1974, American Seashells, ed. 2, p. 185, fig. 1939, color pl. 9, fig. 1939.

Paziella pazi (Crosse). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 86 (in part), pl. 26, fig. 3 only; FAIR, 1976, The Murex Book, p. 65, pl. 15, fig. 197.

Poirieria pazi (Crosse). ABBOTT and DANCE, 1982, Compendium of Seashells, p. 143 (color photograph).

Holotype: Collection of Journal de Conchyliologie [Mus. Natl. Hist. Nat. Paris] (Clench and Pérez Farfante, 1945, p. 45); height 35 mm, diameter (including spines) 29.5 mm.

Type locality: "Maris Antillarum."

Occurrence: Recent only, eastern Florida to Honduras, including Gulf of Mexico.

Figured specimen: USNM 678944; height 39 mm, diameter (excluding spines) 19 mm; locality, *Silver Bay* Station 2481, off Hollywood, Florida, in 200 fathoms [366 meters].

Discussion: Radwin and D'Attilio (1976, p. 86) placed into synonymy all four Recent forms of *Paziella* found in the western Atlantic. They may be correct for two species, *P. pazi* and *P. nuttingi*, which sometimes do occur together in the deeper waters around southern and western Florida. For example, Houston Museum of Natural Science collections made from west of Cape San Blas and south of the Dry Tortugas contain both species, although there are many more lots with only one species.

However, the two forms are readily separable, even though detailed examination fails to reveal notable differences in the protoconch, early whorls, apertural denticulations, etc. The immediate obvious difference is the length and angle of the spines: *P. nuttingi* has short spines, those at the shoulder directed adapically; *P. pazi* has long spines, those at the shoulder directed nearly horizontally, those on the siphonal canal recurved adapically.

Due to the deep habitat (200 to 600 meters) little is known of the ecology of these species. However, *P. pazi* appears to be a mud-dweller and *P. nuttingi* a shell-rubble or hard-bottom dweller. Thus, the difference in spines may be a reflection of the soft vs. hard bottom. But, why are there no intermediate forms? All examples easily can be placed into one "form" or the other;

therefore, it is equally reasonable that there are two distinct species with differing ecologic preferences.

Poirieria (Paziella) nuttingi (Dall)
Plate 7, figure 2

Poirieria (Paziella) nuttingi (Dall). VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 24, pl. 5, fig. 4 (holotype); ABBOTT, 1974, American Seashells, ed. 2, p. 185, fig. 1941 (holotype).

Paziella pazi (Crosse). RADWIN and D'ATTILIO, 1976, p. 86 (in part, not of Crosse), pl. 26, fig. 1 only.

Paziella nuttingi (Dall). FAIR, 1976, The Murex Book, p. 63, pl. 15, fig. 201 (holotype).

Poirieria nuttingi (Dall). ABBOTT and DANCE, 1982, Compendium of Seashells, p. 143 (holotype, color photograph).

Holotype: USNM 107372; height 44.4 mm, diameter (excluding spines) 20.5 mm.

Type locality: Eight miles [13 km] east of Sand Key [near Key West], Florida, in 15 fathoms [27 meters].

Occurrence: Recent only, off southern and western Florida.

Figured specimen: USNM 869506; height 35.3 mm, diameter (excluding spines) 16.6 mm; locality, west of Cape San Blas, Florida, in 200 meters.

Discussion: As noted above, there is a certain resemblance between *P.(P.) pazi* and *P.(P.) nuttingi;* likewise there is a certain resemblance between *P. nuttingi* and *P.(P.) oregonia.* In the latter case, the primary difference is size; *P. oregonia* is approximately twice as large as *P. nuttingi.* The ranges do not overlap, with *P. nuttingi* confined to the Gulf of Mexico and *P. oregonia* confined to the northern coast of South America.

Previously (Vokes, 1970, p. 23), I noted that, although the holotype of *P. nuttingi* does not show denticulations on the inner side of the outer lip, other specimens do. One such shell is shown here (pl. 7, fig. 2). Another similar example was figured by Radwin and D'Attilio (1976, pl. 26, fig. 1) as "*P.pazi.*"

Poirieria (Paziella) oregonia (Bullis)
Plate 7, figure 3

Poirieria (Paziella) oregonia (Bullis). VOKES, 1970, Tulane Stud. Geol. Paleont, v. 8, no. 1, p. 26, pl. 5, fig. 3 (holotype); ABBOTT, 1974, American Seashells, ed. 2, p. 186.

Paziella pazi (Crosse). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 86 (in part, not of Crosse), pl. 26, fig. 2 only (AMNH 111202 – paratype, *P. oregonia);* text-fig. 50 (radula).

Paziella oregonia (Bullis). FAIR, 1976, The Murex Book, p. 64, pl. 15, fig. 200 (holotype).

Holotype: USNM 635149; height 85.2 mm, diameter (excluding spines) 37.8 mm.

Type locality: *Oregon* Station 2023, 95 miles [153 km] north of Pte. Mana, French Guiana, in 135 fathoms [247 meters].

Occurrence: Recent only, from Trinidad south along the coast of Brazil to the Equator (Bullis, 1964, p. 106).

Figured specimen: USNM 635149 (holotype).

Discussion: Also placed in the synonymy of *P. pazi* by Radwin and D'Attilio, this large species more nearly resembles *P. nuttingi.* One could consider this a geographical subspecies of *P. nuttingi,* but there are strong reasons to separate it as a distinct species. In addition to the larger size, there are always two rows of spines on the siphonal canal of *P. oregonia* and only one row on *P. nuttingi.* But the most striking difference is the surface of *P. oregonia,* which is covered by a thin layer of a cream colored material, similar to an intritacalx but harder and not as easily removed as the typical chalky layer of other muricine species.

Clench and Pérez Farfante (1945, p. 45) report *P. pazi* from the Lesser Antilles (after Tryon, 1880, p. 134). This record may refer to *P. oregonia,* for no specimens of true *P. pazi* are known from so far south.

Subgenus FLEXOPTERON Shuto, 1969

Flexopteron SHUTO, 1969, Mem. Fac. Sci., Kyushu Univ., Ser. D., Geol., v. 19, no. 1, p. 111.

Type species: *Flexopteron philippinensis* Shuto, 1969, by original designation.

Discussion: When this subgenus was discussed previously (Vokes, 1970, p. 5), several fossil species were referred to this taxon, ranging from the Caribbean to Europe to the Philippine type of the subgenus, but there were no known living representatives of the line. Since then Houart (1985, p. 166, figs. 3a-d) has described a living species off Madagascar, *P. priminova,* from an average depth of 330

meters. He also figured the radula of this new species, which, although not greatly different from *P. zelandica,* is most similar to those "Trophonine" genera such as *Boreotrophon* and *Nipponotrophon* that I consider more closely related to *Poiriera* than to *Trophon* s.s. Until the systematics of the subfamily Trophoninae are better understood, it is best to leave all these taxa in their accustomed place.

Poirieria (Flexopteron) collata (Guppy)
Plate 6, figures 5, 6

Poirieria (Flexopteron) collata (Guppy). VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 26, pl. 4, fig. 6 (paratype); VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 57, pl. 5, fig. 5.

Holotype: USNM 115479; height 22 mm, diameter 15 mm.

Type locality: Bowden Formation; Bowden, Parish of St. Thomas, Jamaica (= TU 705).

Occurrence: Gurabo and Mao formations, Dominican Republic; Bowden Formation, Jamaica.

Figured specimens: Fig. 5, USNM 323881; height 20.8 mm, diameter 14.2 mm; locality TU 1227. Fig. 6, USNM 462679; height (incomplete) 17 mm, diameter 12.8 mm; locality TU 1227. Additional localities: TU 1208, 1250, 1357, 1381.

Discussion: This species was described originally from the deep-water beds of the Bowden Formation, Jamaica. We now have several specimens of *P.(F.) collata* from the deepest water facies of the Gurabo Formation of the Dominican Republic in beds estimated to have been deposited in 150 to 350 meters depth. This agrees with the depth preference of the single living representative of the group, *P.(F.) primanova* Houart, 1985, described from an average depth of 330 meters in the Indian Ocean.

Subgenus PAZINOTUS Vokes, 1970

Pazinotus VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 27.

Type species: *Eupleura stimpsonii* Dall, 1889, by original designation.

Discussion: When this subgenus was described it included but one fossil species (*P. bowdenensis*) and one living species (*P. stimpsonii*) in the New World, plus a few European fossil species. Since that time, several new species have been recognized, including *Pazinotus adventus* Poorman, 1980, considered to be the eastern Pacific cognate (see Vokes, 1984, p. 212, pl. 1, figs. 5, 6) of *P. bowdenensis,* which proves to be still living in the western Atlantic, and several living Indo-Pacific forms both newly described and old species newly assigned to the group.

However, one Recent species originally assigned to the group, *"Murex" funafutiensis* Hedley, 1899, is instead a member of a superficially similar group, *Pygmaepterys* (type species: *Murex alfredensis* Bartsch, 1915) (see Vokes and D'Attilio, 1980, p. 52, pl. 2, figs. 4, 5). Species referred to this latter group differ from members of *Pazinotus* in their complex surface ornamentation generated by numerous fine axial growth lines crossing numerous spiral threads. The surface of *Pazinotus,* except for the major spiral cords, is almost smooth, with a linen-like ornamentation at most. But both groups have four or more winged varices, somewhat scalloped by the spiral cords, and a denticulate aperture. Both are also small (under 20 mm) and the two may be easily confused.

In a recent paper (Houart, 1991b, p. 40) has shown that certain species, which have a morphological similarity to those of *Pazinotus,* have a radula more akin to the Muricopsinae, indicating they would be better placed in *Pygmaepterys*. One of the two species for which he has radular information, *P. spectabilis* Houart, 1991, has an overall morphology not unlike *P.(P.) hystricina* (Dall), causing a question as to the correct familial placement of that species. However, the second, *P. sibogae* (Schepman, 1911), although having the same type of spinose webbed varices has a makedly scabrous shell surface, so much so that it was originally assigned to the genus *Latiaxis*. As Houart notes, only when we have radular data for all of the species, especially *P.(P.) stimpsonii* (Dall), type of *Pazinotus,* will we be able to make a final decision.

In addition to the living forms now recognized, one other fossil species, originally treated as *Hexaplex silvaticus* (Palmer), has been recognized as the earliest member of the subgenus.

POIRIERIA (PAZINOTUS) SILVATICA (Palmer)
Plate 7, figures 4-6

Hexaplex (Hexaplex) silvaticus (Palmer). VOKES, 1968, Tulane Stud. Geol., v. 6, no. 3, p. 96, pl. 1, figs. 2, 5.

? Synonym:

Murex angulatus MEYER, 1886, Alabama Geol. Surv., Bull. 1, pt. 2, p. 74, pl. 2, fig. 18 (not *M. angulatus* Solander *in* Brander, 1766, *etc.*).

Holotype: PRI 3003; height (incomplete) 6 mm, diameter 5 mm.

Type locality: Cook Mountain Formation; Lapiniere Landing, Ouachita River, Ouachita Parish, Louisiana.

Occurrence: Weches Formation and Stone City Beds, Texas; Cook Mountain Formation, Louisiana and Texas; Wautubbee Formation, Mississippi; (?)Moodys Branch Formation, Mississippi.

Figured specimens: Fig. 4, USNM 462680; height 9.6 mm, diameter 6.1 mm; locality TU 85. Fig. 5, USNM 462681; height 5.5 mm, diameter 3.4 mm; locality TU 1258. Fig. 6, USNM 638830 (holotype, *Murex angulatus*); height 9 mm, diameter 5.5 mm; locality, (?)Jackson, Mississippi. Additional localities: TU 61, 1262, 1529.

Discussion: When Palmer (1937, p. 264) originally described this species as *Murex vanuxemi silvaticus,* she stated that the "variety" differed from the typical *M. vanuxemi* in being smooth between the varices. Later (Vokes, 1968, p. 96), I declared that this difference was sufficient to place the two forms in separate species. With the description of the subgenus *Pazinotus,* the smoothness was recognized as a generic character. Another generic character formerly overlooked is the presence of from one to three denticles on the columellar lip.

As is typical of *Pazinotus,* most specimens of *P.(P.) silvatica* are relatively small (under 10 mm) but the species does attain a larger size, one specimen (locality TU 85) is almost 18 mm in height. Well preserved examples show a small flange along the abapertural portion of the varices.

This is not a rare species, it occurs at numerous localities in Mississippi, Louisiana, and Texas. Palmer (1937, pl. 35, fig. 11) cites the paratype (PRI 3004) as from the Gosport Sand, Alabama [which I repeated in 1968] but this must be a mistake. In her text (1937, p. 265) Palmer does not mention the Gosport nor is there any mention in Palmer and Brann (1966, p. 784). We have not taken it at any Gosport localities.

In Palmer and Brann (*ibid.*) the species is said to occur in the Weches Formation, Texas, although there are no localities in the Weches cited. However, we have taken several examples at three different Weches localities.

"Murex" angulatus Meyer was described from Jackson, Mississippi. Examination of the type species (figured in Vokes, 1968, pl. 1, fig. 5; refigured here pl. 7, fig. 6) shows that it is very like specimens of *P. silvatica.* Dockery has reported nothing like *M. angulatus* from the Late Eocene Moodys Branch Formation in Mississippi (Dockery, 1977, 1980) nor have we found anything like it in that formation. Therefore, one might conclude that the "Jackson" reference is an error, and that the specimen actually was collected in the Newton area, where *P. silvatica* is found at every locality in the early Middle Eocene Wautubbee Formation.

POIRIERIA (PAZINOTUS) BOWDENENSIS Vokes
Plate 7, figures 7, 8

Poirieria (Pazinotus) bowdenensis VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 27, pl. 5, fig. 5; VOKES, 1976, Tulane Stud. Geol. Paleont., v. 12, no. 3, p. 110 (footnote); VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 212, pl. 1, fig. 6 (holotype).

Holotype: USNM 369621; height 13.9 mm, diameter 6 mm.

Type locality: Bowden Formation; Bowden, Parish of St. Thomas, Jamaica (= TU 705).

Occurrence: Agueguexquite Formation, Mexico; Bowden Formation, Jamaica; Moín Formation, Costa Rica. Recent, Gulf of Mexico (so far as known).

Figured specimens: Fig. 7, USNM 869507; height 11.5 mm, diameter 6.2 mm; locality, off Cape San Blas, Florida, in 183 meters. Fig. 8, USNM 462682; height 12 mm, diameter 6.2 mm; locality TU 1240. Additional localities: TU 638, 1046, 1239.

Discussion: When *P. bowdenensis* originally was described there was but one fossil specimen known. Once described, the species was recognized living in the Gulf of Mexico, at depths of about 200 meters. Many specimens resulted from the dredgings of James Moore, Bradenton, Florida, who generally dredged in the Gulf off southwestern Florida. Dredging in other localities might reveal that the species is not confined to the Gulf.

In addition to the living examples, we

now have collected several specimens in both the Agueguexquite Formation, Veracruz, Mexico, and the Moín Formation, Costa Rica. Surprisingly, we did not find any in the deep-water facies of the Dominican Republic, especially in the Mao Formation, the same age as the Agueguexquite (where we have taken seven specimens).

On the basis of the single type specimen there was some question as to the maximum size of the species. The largest example now at hand measures under 15 mm, and my statement that the type is probably an adult (Vokes, 1970, p. 28) was correct.

Poirieria (Pazinotus) stimpsonii (Dall)
Plate 7, figure 9

Poirieria (Pazinotus) stimpsonii (Dall). VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 28, pl. 5, figs. 6 (lectotype), 7 (paralectotype); ABBOTT, 1974, American Seashells, ed. 2, p. 186, fig. 1947 (after Dall); HOUART, 1991, Nautilus, v. 105, no. 1, p. 31, figs. 6, 7 (protoconch), 32 (shell).

Pazinotus stimpsonii (Dall). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 87, pl. 23, fig. 3; FAIR, 1976, The Murex Book, p. 79, pl. 15, fig. 202 (lectotype); LEAL, 1991, Mar. Prosobranch Gastr. Oceanic Islands Brazil, p. 138.

Lectotype: USNM 87087 (designated by Vokes, 1970, p. 28); height 12 mm, diameter 7 mm.

Type locality: *Blake* Station (unnumbered), off Barbados, in 100 fathoms [183 meters].

Occurrence: Recent only, from Florida to Vitória, Espírito Santo, Brazil (Houart, 1991a, p. 31).

Figured specimen: MCZ 7310 (paralectotype); height 11 mm, diameter 7.4 mm; locality, same as lectotype.

Discussion: Houart (1991a, p. 31) has extended the southern limit of the range of this deep-water species to off Vitória, Espírito Santo, Brazil, in depths from 52 meters to 1,575 meters. The later figure is for a transported dead specimen. This form generally lives at about 200 meters.

Poirieria (?Pazinotus) hystricina (Dall)
Plate 7, figure 10; text-figure 1

Murex (Phyllonotus) hystricinus DALL, 1889, Harvard Mus. Comp. Zool., Bull., v. 18, p. 200, pl. 16 [not pl. 15, as stated], fig. 4 (*Murex hystricina* on pl. expl.); M. SMITH, 1953, Illus. Cat. Rock Shells, p. 9, pl. 9, fig. 7 (after Dall), pl. 12, fig. 5 (paratype).

Murex (Poirieria) hystricinus Dall. CLENCH and PÉREZ FARFANTE, 1945, Johnsonia, v. 1, no. 17, p. 45, pl. 24, figs. 4-7 ("holotype").

Latiaxis hystricinus (Dall). VOKES, 1971, Bulls. Amer. Paleontology, v. 61, no. 268, p. 58.

Poirieria (Paziella) hystricina (Dall). ABBOTT, 1974, American Seashells, ed. 2, p. 185, fig. 1940 (lectotype).

Paziella hystricina (Dall). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 85, pl. 25, fig. 12; D'ATTILIO, 1980, Festivus, v. 12, no. 8, p. 96, text-fig. 1.

Poirieria (?Pazinotus) hystricinus (Dall). VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 212, 215 (footnote).

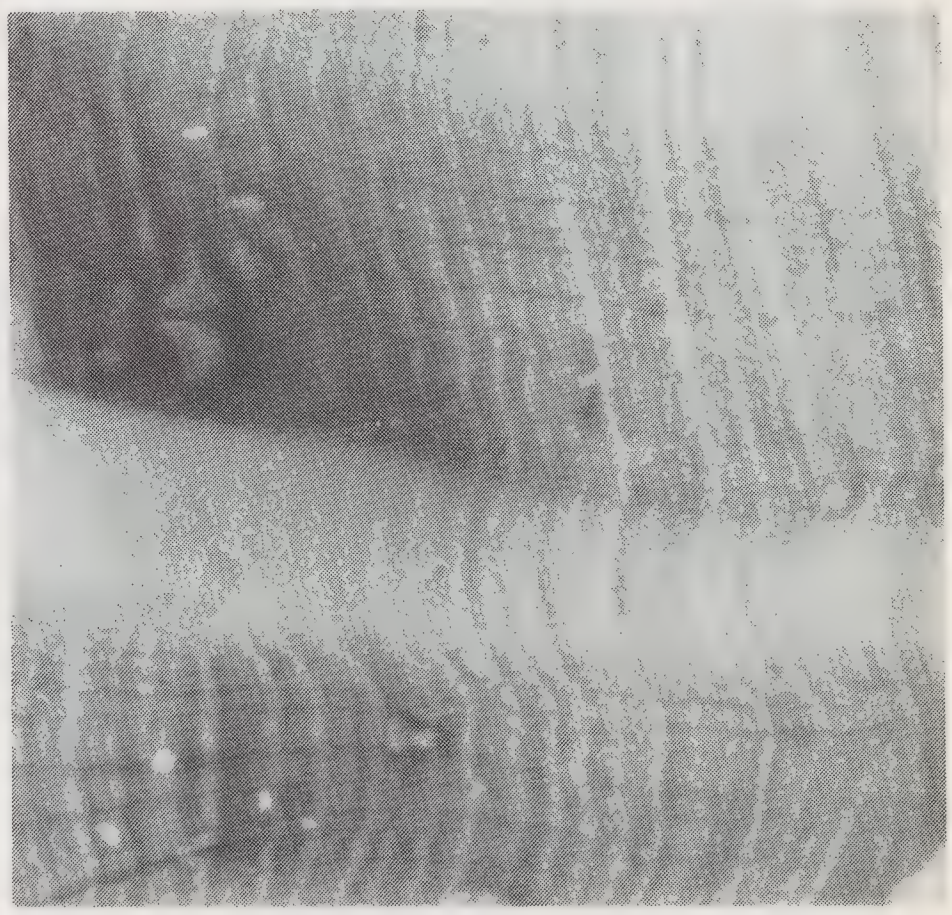
Lectotype: MCZ 7307 (selected by Clench and Pérez Farfante, 1945, p. 46); height 19.5 mm, diameter (including spines) 14.8 mm.

Type locality: *Blake* Station 206, off Martinique, Lesser Antilles, in 170 fathoms [311 meters].

Occurrence: Recent only, from Cuba south to Barbados (D'Attilio, 1980, p. 96).

Figured specimen: MCZ 7307 (lectotype).

Discussion: As the above synonymy shows, the generic placement of this peculiar deep-water species has been a problem for some time. Assignment here to *Pazinotus* is not certain, but the presence of a thin varical webbing would indicate this placement is preferable to *Paziella*, where it has been placed by previous authors. A feature of the shell, not noted by



Text-figure 1. *Poirieria (?Pazinotus) hystricina* (Dall); MCZ 7307 (lectotype); height 19.5 mm, diameter 14.8 mm; locality, *Blake* Station 206, off Martinique, Lesser Antilles. Detail of surface sculpture (X 25).

either Dall or Clench and Pérez Farfante is the beautiful linen-like texture of the shell surface (see text-fig. 1). The only other species with this type of surface ornament is the Philippine *P.(Pazinotus) oliverai* (Kosuge, 1984). (See cover of *Conchologists of America Bulletin,* v. 14, no. 2, June, 1986, for an enlarged photograph showing this pattern.)

Houart (1991b, p. 40) has described a species, *Pazinotus spectabilis,* from New Caledonia, which has a strong similarity to *P.(P.) hystricina.* But, as Houart demonstrates (*ibid.,* text-fig. 39), it has a muricopsine radula, indicating that *Pygmaepterys* may be a better assignment. A second species, also from New Caledonia, *P.(P.) vaubanensis* Houart, 1986, also is morphologically similar to *P. hystricina,* but we have no radular information in this case. Until we have radulae for all of the species involved, including not only *P. hystricina,* but also the type species of both *Pazinotus* and *Pygmaepterys,* assignment to either taxon is only provisional.

Poirieria (Pazinotus) hystricina is rather variable, as discussed by D'Attilio (1980, p. 96), who observed that the number of varices range from seven to nine, the apertural denticles from four to six, and the primary spiral cords (not including that at the shoulder) from three to five.

Compared to other species of *Pazinotus,* this one has a relatively higher spire and shorter canal, giving the shell a more globose appearance. The siphonal canal is strongly deflected, causing the species to resemble certain examples of *Latiaxis spinosus* Hirase, 1908, which is why I erroneously placed it in the genus *Latiaxis* (Vokes, 1971b, p. 58).

Dall (1889, p. 200) did not select a holo-

PLATE 8

Figures Page

1, 2. *Poirieria (Panamurex) laccapoia* (Gardner) 40

1. (X 2) USNM 645618; height 26 mm, diameter 14 mm.
   Locality: TU 458, Florida; Chipola Formation.
2. (X 10) USNM 462683; height 15.6 mm, diameter 7 mm.
   Locality: TU 830, Florida; Chipola Formation.

3-6. *Poirieria (Panamurex) gatunensis* (Brown and Pilsbry) 40

3. (X 1 1/2) NMB H 17382; height 27.9 mm, diameter 19 mm.
   Locality: NMB 17516, Venezuela; Cantaure Formation.
4. (X 1 1/2) USNM 645620; height 40.8 mm, diameter 26 mm.
   Locality: TU 958, Panama; Gatun Formation.
5. (X 2) USNM 462684, height 26 mm, diameter 17.2 mm.
   Locality: TU 757, Panama; Gatun Formation.
6. (X 2) USNM 462685; height 29.8 mm, diameter 18 mm.
   Locality: TU 958, Panama; Gatun Formation.
   (Color pattern under ultraviolet light)

7, 8. *Poirieria (Panamurex) alaquaensis* (Mansfield) 42

7. (X 1 1/2) UNAM IGM 2187 (holotype, *P. dubitalis* Vokes); height 36 mm, diameter 27.5 mm.
   Locality: "Tuxtepec, Oaxaca, Mexico" (almost certainly near Nuevo Teapa, Veracruz, Mexico); Concepcion Inferior Formation.
8. (X 2) USNM 462686; height 21.3 mm, diameter 13.8 mm.
   Locality: TU 1318, Veracruz, Mexico; Concepcion Inferior Formation.

9-12. *Poirieria (Panamurex) clarksvillensis* (Mansfield) (X 2) 44

9. CM 35637 (holotype, *P. susankhanae*); height 19.3 mm, diameter 11.2 mm.
   Locality: APAC quarry, Sarasota, Florida (= TU 1000), "Pinecrest Beds" (= Fruitville Formation).
10. Stephens Coll.; height 19.5 mm, diameter 11.3 mm.
    Locality: TU 1000, Florida; Fruitville Formation.
11. USNM 462687; height 24 mm, diameter 13.2 mm.
    Locality: TU 60, Florida; Jackson Bluff Formation.
12. Stephens Coll.; height 23 mm, diameter 13.5 mm.
    Locality: TU 1000, Florida; Fruitville Formation.

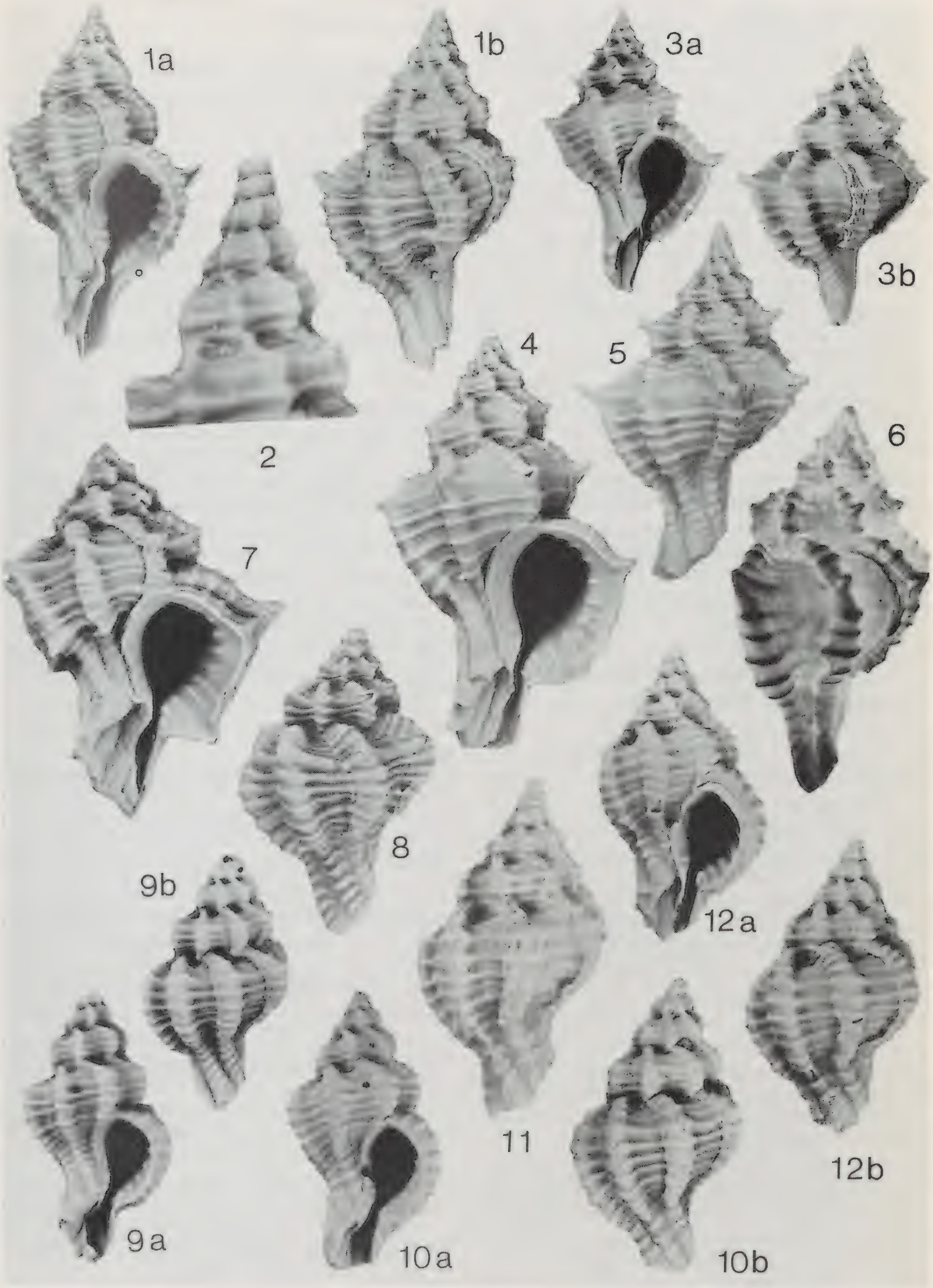


PLATE 8

type for *"Murex" hystricinus,* reporting it from three different stations in the Caribbean. Clench and Pérez Farfante (1945, p. 46) cited the specimen from Station 206 (MCZ 7307) as the "holotype," but it is more correctly the lectotype. Presumably, it is the shell figured by Dall, although that one was said to measure 21 mm. There are certain minor differences in the aperture but this may be "artistic license." The specimen from Station 158, off Montserrat, is in the U.S. National Museum (USNM 87083) and has been illustrated by Kaicher (1978, no. 1619). The third specimen, from Station 2134, south of Cuba, is also there (USNM 93959) and has been figured by M. Smith (1953, pl. 12. fig. 5). Certainly, neither of these matches the original illustration as well as the MCZ specimen.

As reported by Clench and Pérez Farfante, this is an extremely deep-water species, living in depths of 148 to 254 fathoms [271 to 465 meters]. Radwin and D'Attilio (1976, p. 86) gave a depth range of 296 to 552 meters, but D'Attilio (1980, p. 96) reports a number of specimens from only 165 meters, off Barbados.

Subgenus PANAMUREX Woodring, 1959

Panamurex WOODRING, 1959, U.S. Geol. Surv., Prof. Paper 306-B, p. 217.

Type species: *Murex gatunensis* Brown and Pilsbry, 1911, by original designation.

Discussion: The protoconch and early teleoconch whorls of *P.(P.) laccapoia* are much attenuated (see pl. 8, fig. 2) and the same is true in *P. gatunensis,* type species of *Panamurex* (see pl. 8, fig. 5). Other members that lack the labral tooth, such as *P.(P.) fusinoides,* have a much lower spire and spinose early teleoconch whorls (see pl. 9, fig. 4), in addition to a row of spines encircling the siphonal canal. This may indicate that there are two separate lines included in *Panamurex,* as Woodring indicated when he observed that *P. heilprini* "evidently represents a different muricine genus" (1959, p. 218).

Similarly, certain members lack both the labral tooth and the spines encircling the siphonal canal. These members resemble species of the genus *Calotrophon* and have been placed there by some authors. As all three groups appear to be very closely related I will retain them in *Panamurex,* but will separate them into Species Groups.

Species Group 1: *Poirieria (Panamurex) gatunensis*

Discussion: The members of this Species Group have a strong labral tooth but no spines encircling the siphonal canal. In addition, they have a heavier intritacalx than most members of *Poirieria* (excluding those possibly referred to *Bathymurex,* see above). In fossil specimens this deciduous covering commonly is lost but enough remains on isolated specimens to indicate that all species included in *Panamurex* had this layer to some extent, but in the Group of *P. gatunensis* it probably was much thicker.

Poirieria (Panamurex) laccapoia (Gardner)
Plate 8, figures 1, 2

Poirieria (Panamurex) laccapoia (Gardner). VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 31, pl. 7, fig. 1; VOKES, 1972, Earth Science, v. 25, no. 3, p. 124, pl. 2, fig. 6.

Holotype: USNM 371880; height 18 mm, diameter 9.8 mm.

Type locality: USGS 2213, Chipola Formation; Chipola River, one mile [0.4 mi = 0.6 km] below Bailey's Ferry, Calhoun County, Florida (= TU 457).

Occurrence: Oak Grove Sand, Chipola and Shoal River formations, Florida; unknown formation, Chiapas, Mexico.

Figured specimens: Fig. 1, USNM 645618; height 26 mm, diameter 14 mm; locality TU 458. Fig. 2, USNM 462683; height 15.6 mm, diameter 7 mm; locality TU 830. Additional localities: TU 549, 820, 823, 949, 951, 1020, 1050, 1097, 1098.

Discussion: Poirieria (Panamurex) laccapoia is especially abundant in the lower beds of the Chipola Formation, along Tenmile Creek (localities TU 546, 830, 951), but it occurs at almost every locality on Tenmile Creek and the Chipola River. We have only a few examples from the calcarenite facies on Farley Creek.

Poirieria (Panamurex) gatunensis (Brown and Pilsbry)
Plate 8, figures 3-6

Poirieria (Panamurex) gatunensis (Brown and Pilsbry). VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 40, pl. 7, fig. 6.

Not *Panamurex gatunensis* (Brown and Pilsbry). PETUCH, 1981, Malacologia, v. 22, no. 2, p. 322, figs. 33, 34; PETUCH, 1987, New Caribbean Moll. Faunas, pl. 15, fig. 8 [= *Poirieria (Paziella) petuchi,* n. sp.].

Holotype: ANSP 1720; height (incomplete) 32 mm, diameter 21 mm.

Type locality: Gatun Formation; Gatun Locks excavation, Canal Zone, Panama.

Occurrence: Cantaure and Punta Gavilán formations, Venezuela; Gatun Formation, Panama; Tubará Group, Colombia.

Figured specimens: Fig. 3, NMB H 17382; height 27.9 mm, diameter 19 mm; locality NMB 17516 (= TU 1269). Fig. 4, USNM 645620; height 40.8 mm, diameter 26 mm; locality TU 958. Fig. 5, USNM 462684, height 26 mm, diameter 17.2 mm; locality TU 757. Fig. 6, USNM 462685; height 29.8 mm, diameter 18 mm; locality TU 958. Additional localities: TU 1429, 1431, 1432, 1433.

Discussion: As noted previously (Vokes, 1970, p. 42), this species is widespread, ranging from Panama to Venezuela; however, the age is no longer "Middle Miocene." In Panama and Colombia the species occurs in Pliocene beds, and in the Gibson Smith Collection, now at the Naturhistorisches Museum, Basel, Switzerland, there are three large examples of *P. gatunensis* from the Pliocene Punta Gavilán Formation of Venezuela.

But the Cantaure Formation, Venezuela, where Jung (1965, p. 523, pl. 69, figs. 11, 12) reported the species as "cf. *gatunensis,*" is Early Miocene. Examination of the numerous Cantaure specimens (pl. 8, fig. 3) in the Gibson Smith Collection (40 in all) reveals that they are true *P.(P.) gatunensis* and not the correlative *P.(P.) laccapoia,* as might be anticipated.

The Chipola and Cantaure formations are considered to be of the same late Early Miocene age and yet the muricid faunas are almost totally different. There are a few cognate pairs of species, especially in the subgenus *Panamurex* (see Table 1), but only *Haustellum gilli* (Maury, 1910) and *Murexiella (Subpterynotus) textilis* (Gabb, 1973) occur in both formations. Whether this is a result of ecologic differences or simple geographical separation is not certain but what we see here is the initiation of the two biogeographic provinces Petuch (1982b, p. 280) termed the "Caloosahatchian" and the "Gatunian" Provinces.

Under ultraviolet light the color pattern of *P. gatunensis* is shown as dark lines marking the tops of each of the spiral cords, most intense where the cords cross the varices (pl. 8, fig. 6). This is essentially the same pattern as in *P.(P.) fusinoides* (pl. 9, fig. 3b), and *P.(P.) eugeniae,* n. sp., an indication of the close relationship of these three Species Groups.

TABLE 1

Comparison of Muricinae in the Chipola and Cantaure formations, with possible cognate species.

CHIPOLA FORMATION	CANTAURE FORMATION
Haustellum gilli	*Haustellum gilli*
Chicoreus (Chicoreus) dujardinoides	*Chicoreus (Chicoreus) corrigendum*
Chicoreus (Chicoreus) lepidotus	–
Chicoreus (Chicoreus) elusivus	*Chicoreus (Chicoreus) cornurectus*
Chicoreus (Siratus) chipolanus	*Chicoreus (Siratus) quirosensis*
–	*Chicoreus (Siratus) denegatus*
Chicoreus (Siratus) juliagardnerae	–
Chicoreus (Siratus) sextoni	–
Chicoreus (Phyllonotus) louisae	–
Chicoreus (Phyllonotus) infrequens	–
Chicoreus (Phyllonotus) folidodes	–
Hexaplex veatchi	–
Pterynotus (Pterynotus) praepatagiatus	–
Pterynotus (Pterynotus) hoerlei	–
Poirieria (Panamurex) laccapoia	*Poirieria (Panamurex) gatunensis*
Poirieria (Panamurex) fusinoides	*Poirieria (Panamurex) improcerus*
Poirieria (Panamurex) lychnia	*Poirieria (Panamurex) gibsonsmithi*
Poirieria (Panamurex) mauryae	–
Dermomurex (Dermomurex) matercula	–
Dermomurex (Trialatella) farleyensis	–
Dermomurex (Takia) curviductus	–
Dermomurex (Takia) vaughani	–

Petuch (1981, p. 322, figs. 33, 34) reported a single living specimen (USNM 784571) from off the coast of Venezuela, in 35 meters depth, as *Panamurex gatunensis*. At the time, he stated that E. Vokes had suggested the specimen was a new species. It differs from *P. gatunensis* in having open flanges along the varical ribs and in lacking the labral tooth seen in that species. Even more importantly, it does not have rugae on the columellar wall and, therefore, it should not be referred to *Panamurex*, but is a new species of *Paziella*, described above as *Poirieria (Paziella) petuchi*.

Poirieria (Panamurex) alaquaensis (Mansfield)
Plate 8, figures 7, 8

Poirieria (Panamurex) alaquaensis (Mansfield). VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 43, pl. 7, figs. 3 (holotype), 4.

Synonym:

Poirieria (Panamurex) dubitalis VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 42, pl. 7, fig. 5.

Holotype: USNM 373148; height 15 mm, diameter 9 mm.

Type locality: USGS 12046, Choctawhatchee Group; Vaughan Creek, about three miles [4.8 km] from its junction with Alaqua Creek, about 6 1/2 miles [10.4 km] nearly south of DeFuniak Springs, Walton County, Florida.

Occurrence: Choctawhatchee Group (?Jackson Bluff Formation); Concepcion Inferior and Agueguexquite formations, Veracruz, Mexico.

Figured specimens: Fig. 7, UNAM IGM 2187 (holotype, *P. dubitalis);* height 36 mm, diameter 27.5 mm; locality, "Tuxtepec, Oaxaca, Mexico" (almost certainly near Nuevo Teapa, Veracruz, Mexico). Fig. 8, USNM 462686; height 21.3 mm, diameter 13.8 mm; locality TU 1318. Additional localities: TU 1025, 1514, 1515.

Discussion: We now have numerous specimens of *P.(P.) alaquaensis* from the Concepcion Inferior Formation of Veracruz, Mexico, and it is clear that the species I originally described as *P.(P.) dubitalis*, said to be from "Tuxtepec, Oaxaca," is the same. At that time I expressed doubt about the locality and suggested that because two specimens of the Agueguexquite Formation species *Typhis carmenae* Gertman, 1969, were in the same lot, *P. dubitalis* came from the Agueguexquite Formation, probably near Coatzacoalcos.

PLATE 9

Figures Page

1. *Poirieria (Panamurex) macneili* Vokes (X 2) 45
   USNM 646432; height 23.5 mm, diameter 12.3 mm.
   Locality: "Bryan's Ferry" [= Byram], Pearl River, Hinds County, Mississippi (= TU 66); Byram Formation.
2. *Poirieria (Panamurex) heilprini* (Cossmann) (X 2) 45
   USNM 165089; height 23.5 mm, diameter 13 mm.
   Locality: Ballast Point, Tampa Bay, Hillsborough County, Florida; Tampa Limestone.
3, 4. *Poirieria (Panamurex) fusinoides* (Gardner) 45
   3. (X 1 1/2) USNM 462688; height 50.5 mm, diameter (excluding spines) 21.9 mm.
   Locality: TU 458, Florida; Chipola Formation.
   (3b, color pattern under ultraviolet light)
   4. (X 10) USNM 462689; height 12 mm, diameter 7.1 mm.
   Locality: TU 655, Florida; Chipola Formation.
5, 6. *Poirieria (Panamurex) improcerus* Vokes, n. sp. (X 3) 46
   5. NMB H 17383 (holotype); height 17.5 mm, diameter 11.6 mm.
   Locality: NMB 17529, Venezuela; Caujarao Formation.
   6. NMB H 17384 (paratype); height 15.1 mm, diameter 9.5 mm.
   Locality: NMB 17519, Venezuela; Cantaure Formation.
7, 8. *Poirieria (Panamurex) gabbi* Vokes 49
   7. (X 1 1/2) USNM 375461; height 41.9 mm, diameter 22.4 mm.
   Locality: TU 1412, Dominican Republic; Gurabo Formation.
   8. (X 1 1/2) PRI 33042; height 27.9 mm, diameter 19.9 mm.
   Locality: TU 1210, Dominican Republic; Gurabo Formation.

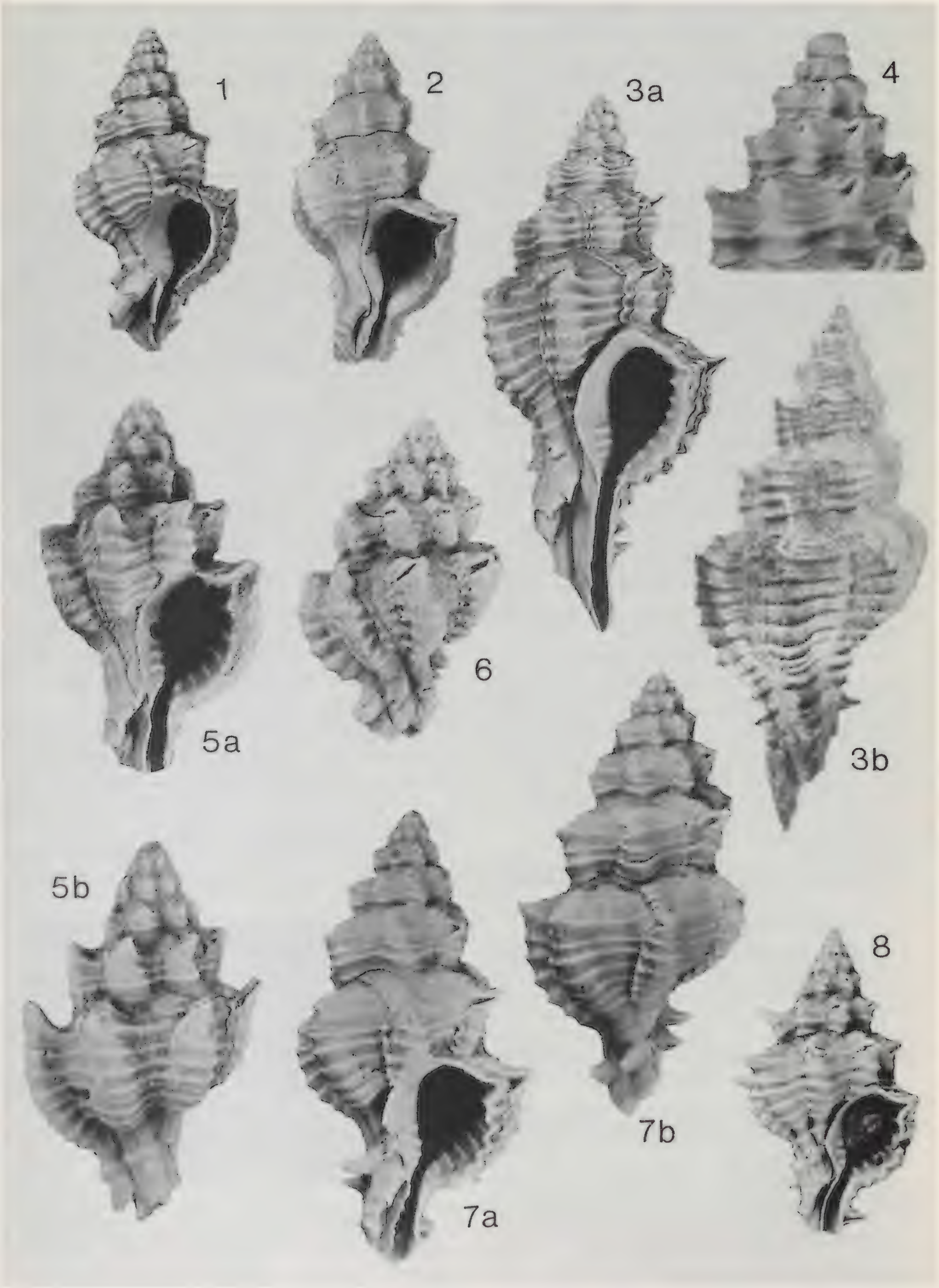


PLATE 9

Later, numerous large specimens of *T. carmenae* were collected from the Concepcion Inferior Formation in the vicinity of Nuevo Teapa (TU 1025, 1318, 1514, 1515), showing the species is not confined to the Agueguexquite Formation. At these same localities we have collected several specimens of *P. alaquaensis* and the two clearly occur together in the Concepcion Inferior. The single rolled specimen from the Agueguexquite Formation (TU 638), as cited previously, remains the only record of *P. alaquaensis* from that formation; it almost certainly is reworked.

Formerly, these beds were all considered Late Miocene in age, but they are now known to be Early Pliocene, with the Concepcion Inferior slightly older (N.19) than the Agueguexquite (N.20) (see Kohl, 1985, fig. 7). The Concepcion Inferior is a deep-water facies, as are the exposures of the Choctawhatchee Group south of De-Funiak Springs. In age, the beds on Vaughan Creek are the same as those at Jackson Bluff, but because of the facies difference, the formational name to be applied to these beds remains unclear.

Presumably *P.(P.) alaquaensis* lived in a deeper habitat than most of the members of *Panamurex,* including *P.(P.) clarksvillensis,* its shallow-water contemporary. All known specimens of *P. alaquaensis* are from deep-water formations, with the exception of the single reworked specimen in the Agueguexquite Formation.

Poirieria (Panamurex) clarksvillensis (Mansfield)

Plate 8, figures 9-12; text-figure 2

Poirieria (Panamurex) clarksvillensis (Mansfield). VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 43, pl. 7, fig. 7.

Synonym:

Panamurex susankhanae PETUCH, 1991, W.H. Dall Paleont. Resh. Center, Spec. Publ. 1, p. 26, pl. 4, fig. 6.

Holotype: USNM 496424; height 30 mm, diameter 17 mm.

Type locality: Jackson Bluff Formation; Four Mile Creek, one-half mile [0.8 km] north of Clarksville, Calhoun County, Florida (= TU 73).

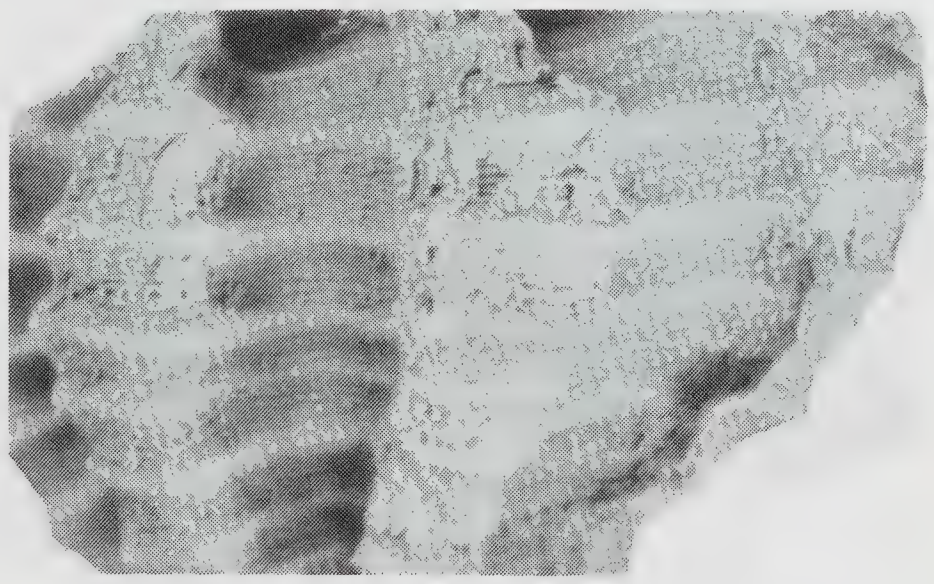
Occurrence: Jackson Bluff, Fruitville (= "Pinecrest Beds"), Pinecrest Beds, and Tamiami formations, Florida.

Figured specimens: Fig. 9, CM 35637 (holotype, *P. susankhanae*); height 19.3 mm, diameter 11.2 mm; locality, APAC quarry, Sarasota, Florida (= TU 1000). Fig. 10, Stephens Coll.; height 19.5 mm, diameter 11.3 mm; locality TU 1000. Fig. 11, USNM 462687; height 24 mm, diameter 13.2 mm; locality TU 60. Fig. 12, Stephens Coll.; height 23 mm, diameter 13.5 mm; locality TU 1000. Additional locality: TU 1177.

Discussion: Poirieria (Panamurex) clarksvillensis is fairly common at Jackson Bluff (TU 60) in northern Florida. It is less abundant in the correlative beds of southern Florida, but we have examples from localities referred to the Tamiami Formation (TU 1177) by Meeder (1990, fig. 3), the Fruitville Formation (= "Pinecrest Beds"; TU 1000), and the "true" Pinecrest Formation (TU 797).

A specimen from the Fruitville Formation at Sarasota, Florida, was described as *Panamurex susankhanae* (Petuch, 1991, p. 26, pl. 4, fig. 6). Petuch compared his new species to *P. alaquaensis,* stating that it differs in the more elongate shell and in lacking the shoulder spines that characterize the latter. The spines are not conspicuous in smaller examples (see pl. 8, fig. 8) but his shell does have a higher spire than is typical of *P. alaquaensis.* Unfortunately, he did not compare his specimen to *P. clarksvillensis,* which also occurs at Sarasota. On the basis of this single shell, the differences between *P. susankhanae* and a young example of *P. clarksvillensis* (compare pl. 8, figs. 9 and 10) are minor and they are placed in synonymy.

From the remnant patches of intritacalx remaining on most specimens, *P. clarks-*



Text-figure 2. *Poirieria (Panamurex) clarksvillensis* (Mansfield); USNM 462687; height 24 mm, diameter 13.2 mm; locality TU 60. Detail of surface, showing remnant patches of intritacalx (X 5).

villensis (see text-fig. 2) probably had the heaviest coating of any of the members of *Panamurex*. In life it may well have looked like a member of the genus *Dermomurex*.

Species Group 2: *Poirieria (Panamurex) fusinoides*

Discussion: The members of this group differ from the typical *P. gatunensis* in lacking the labral tooth. In addition, there is a row of spines encircling the siphonal canal and the early whorls are also spinose (see pl. 9, fig. 4). This is the oldest of the Species Groups, extending back to the Early Oligocene.

In my previous study (Vokes, 1970), there was but one living species referred to this Species Group – *P.(P.) carnicolor* (Clench and Pérez Farfante, 1945). Since then a new species from off Somalia, *P.(P.) hemmenorum* Houart and Muhlhauser, 1990, which is very like the Chipola species *P. fusinoides*, has been described.

POIRIERIA (PANAMUREX) MACNEILI Vokes
Plate 9, figure 1

Poirieria (Panamurex) macneili VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 30, pl. 6, figs. 1, 2 (new name for *Murex simplex* Aldrich, 1886, *non* Philippi, 1841); MACNEIL and DOCKERY, 1984, Mississippi Bur. Geol., Bull. 124, p. 126, pl. 31, figs. 15, 16.

Holotype: USNM 644618; height 15.5 mm, diameter 9 mm.

Type locality: Byram Formation; "Bryan's Ferry" [= Byram], Pearl River, Hinds County, Mississippi (= TU 66).

Occurrence: Byram Formation, Mississippi.

Figured specimen: USNM 646432; height 23.5 mm, diameter 12.3 mm; locality same as holotype. Additional locality: TU 1203.

Discussion: Only one additional specimen has been collected of this earliest American member of the subgenus *Panamurex*. It is from Redwood, Mississippi, north of Vicksburg, the first example not from the type locality. MacNeil and Dockery (1984, p. 124) did not have additional material and ours is too incomplete to figure. The number cited for the holotype of this species in MacNeil and Dockery (1984, p. 126 – USNM 481661) is incorrect. According to Warren Blow, of the U.S. National Museum (personal communication, October, 1991), this number pertains to a totally different specimen.

POIRIERIA (PANAMUREX) HEILPRINI
(Cossmann)
Plate 9, figure 2

Poirieria (Panamurex) heilprini (Cossmann). VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 30, pl. 6, figs. 3, 4.

Holotype: WFIS 870; height "slightly exceeding one inch;" diameter "half-inch" (Heilprin, 1886, p. 108).

Type locality: Tampa Limestone; Ballast Point, Tampa Bay, Hillsborough County, Florida.

Occurrence: Tampa Limestone, Florida.

Figured specimen: USNM 165089; height 23.5 mm, diameter 13 mm; locality same as holotype.

Discussion: Other than that the Tampa Limestone is now considered to be of Late Oligocene (Chickasawhayan) age, there is no new information on *P.(P.) heilprini* (Cossmann, 1903; new name for *Murex spinulosa* Heilprin, 1886, *non* Deshayes, 1835).

POIRIERIA (PANAMUREX) FUSINOIDES
(Gardner)
Plate 9, figures 3, 4

Poirieria (Panamurex) fusinoides (Gardner). VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 34, pl. 6, fig. 9; VOKES, 1972, Earth Science, v. 25, no. 3, p. 124, pl. 2, fig. 3.

Holotype: USNM 371854; height 36.7 mm, diameter 16.5 mm.

Type locality: USGS 2564, Chipola Formation; Chipola River, one mile [0.4 mi = 0.6 km] below Bailey's Ferry, Calhoun County, Florida (= TU 457).

Occurrence: Chipola and (?) Shoal River formations, Florida.

Figured specimens: Fig. 3, USNM 462688; height 50.5 mm, diameter (excluding spines) 21.9 mm; locality TU 458. Fig. 4, USNM 462689; height 12 mm, diameter 7.1 mm; locality TU 655. Additional localities: TU 69(?), 826, 1021, 1050, 1098.

Discussion: As noted previously (Vokes, 1970, p. 35), *P.(P.) fusinoides* occurs in exactly the same facies as *P. laccapoia*, with both most abundant in the lower beds of the Chipola Formation along Tenmile Creek and the Chipola River, and rare in the calcarenite facies of Farley Creek. A single incomplete specimen has been recovered from the younger Shoal River Formation.

Previously the largest specimen noted was 45 mm in height, but an even larger specimen has been collected (pl. 9, fig. 3) of this, the largest of the Chipola species of *Panamurex*. The color pattern, as revealed by ultraviolet light (pl. 9, fig. 3b), shows a pattern of dark lines topping the spiral cords, much the same as in *P. gatunensis*.

Poirieria (Panamurex) improcerus
Vokes, n. sp.
Plate 9, figures 5, 6

Description: Shell small for the group, maximum height under 18 mm; probably seven teleoconch whorls in an adult, no specimens with apical whorls preserved. Axial ornamentation of seven heavy, rounded varices on each whorl from the earliest to last formed; these ornamented only by crossing of spiral cords. On approximately fourth teleoconch whorl, sharp somewhat adapically-directed spines developed at crossing of shoulder cord. Spiral ornamentation on earliest whorls of three cords, intercalary cords gradually added; body whorl with seven to nine major cords, varying with the strength of intercalary cords; one spinose cord on the siphonal canal. Shell surface smooth except for spiral cords. Suture sinuated by alternate placement of varices on each succeeding whorl. Aperture oval; inner lip smooth, appressed, with four elongate rugae on anterior half. Inner side of outer lip with about seven strong lirae, located between the position of the external spiral cords. Siphonal canal short, broad, recurved at distal end, forming a small siphonal fasciole.

Holotype: NMB H 17383; height 17.5 mm, diameter 11.6 mm.

Type locality: NMB 17529, Caujarao Formation; San Raphael, Edo. de Falcón, Venezuela.

Etymology of name: Latin *improcerus* – short or undersized.

Occurrence: Caujarao and Cantaure formations, Venezuela.

Figured specimens: Fig. 5, NMB H 17383 (holotype). Fig. 6, NMB H 17384 (paratype); height 15.1 mm, diameter 9.5 mm; locality NMB 17519, Paraguaná Peninsula, Venezuela (= TU 1269).

Discussion: In the Gibson Smith Collection at the Naturhistorisches Museum, Basel, Switzerland, there are several specimens of a new species that is similar in many respects to *P.(P.) fusinoides* but differs in being shorter and smaller. Most of these are from the Mataruca Member of the Caujarao Formation exposed at Carrizal, Edo. de Falcón, Venezuela (NMB loc. 17530), but the two best preserved examples (the holotype and paratype) are from San Raphael, Falcón, and the Paraguaná Peninsula, respectively.

Only the latter specimen is not from the Late Miocene Caujauro Formation, it is from the earlier Cantaure Formation. Whether it is a function of age or of preser-

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PLATE 10

Figures — Page

1, 2. *Poirieria (Panamurex) lychnia* (Gardner) 48
1. (X 2) USNM 462690; height 27.6 mm, diameter (including spines) 15.7 mm.
Locality: TU 950, Florida; Chipola Formation.
2. (X 10) USNM 462691; height 11.7 mm, diameter 8 mm.
Locality: TU 547, Florida; Chipola Formation.

3, 4. *Poirieria (Panamurex) turbinelloides* (Grateloup) (X 3) 48
3. NMB H 17393; height 15 mm, diameter 8.5 mm.
Locality: Lesbarritz, near Gaas, France; Chattian Stage.
4. USNM 463327; height 19.1 mm, diameter 10.1 mm.
Locality: Lagouarde, France; Stampian Stage.

5, 6. *Poirieria (Panamurex) gibsonsmithi* Vokes, n. sp. 48
5. (X 2) NMB H 17385 (holotype); height 26.6 mm, diameter 18.6 mm.
Locality: NMB 17516, Venezuela; Cantaure Formation.
6. (6a X 4, 6b X 10) NMB H 17386 (paratype); height 9.6 mm, diameter 5.6 mm.
Locality: NMB 17516, Venezuela; Cantaure Formation.

7. *Poirieria (Panamurex) mauryae* Vokes (X 3) 49
USNM 462693; height 15.8 mm, diameter 9.6 mm.
Locality: TU 555, Florida; Chipola Formation.

8. *Poirieria (Panamurex) carnicolor* (Clench and Pérez Farfante) (X 2) 49
USNM 679266; height 28 mm, diameter 16 mm.
Locality: *Oregon* Station 5070, off Nevis, Leeward Islands, in 91-110 meters; Recent.

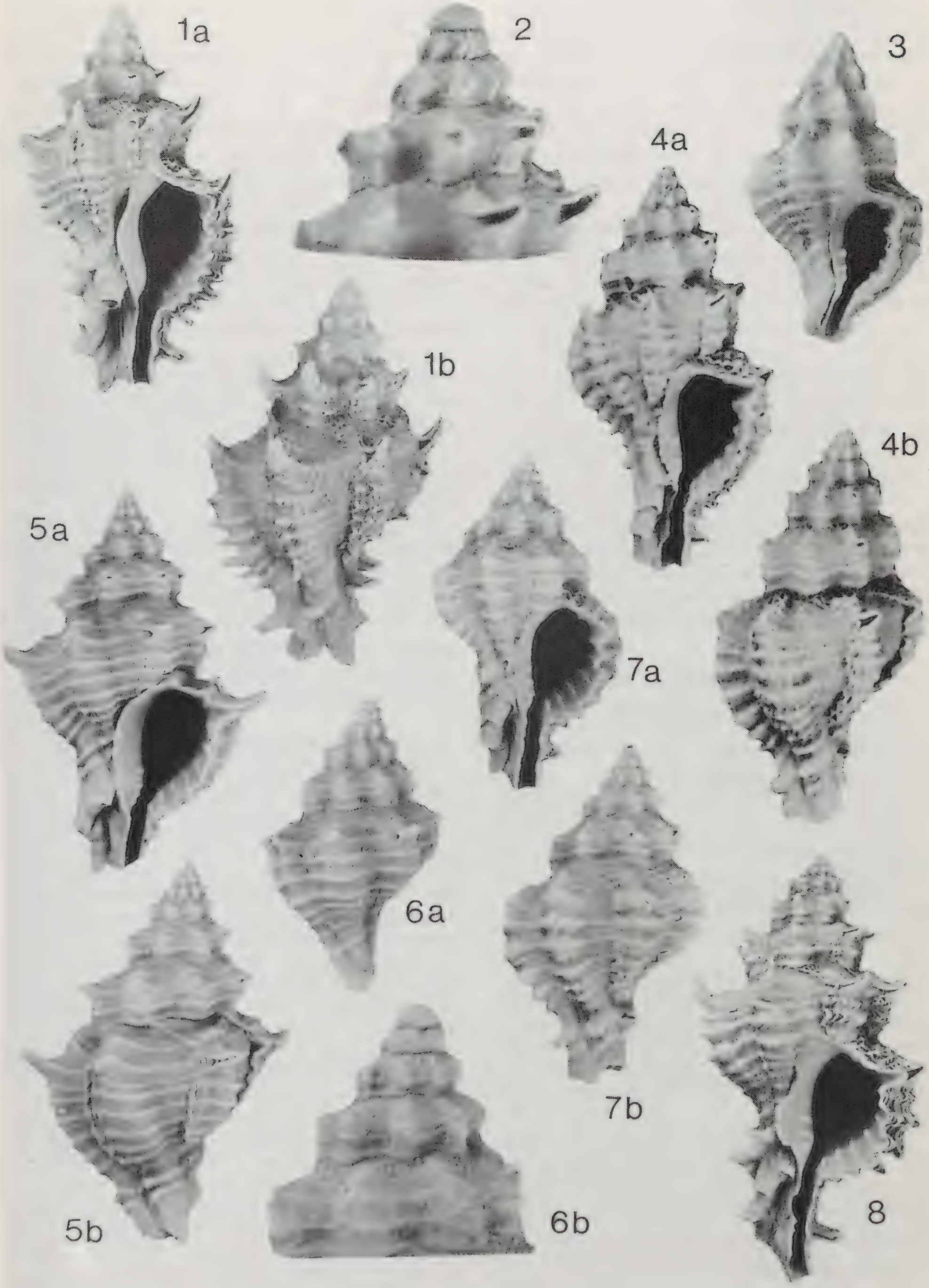

PLATE 10

vation (all of the unfigured paratypes are poorly preserved) is not certain, but the single Cantaure specimen has the spines on the siphonal canal more strongly developed than in the younger examples and the overall shape is more inflated. On the basis of this unique example the differences do not seem to be of specific importance; perhaps additional material will change that viewpoint.

All of the members of this Species Group are similar in general aspect, all have about seven rounded varices, with spines at the shoulder and on the siphonal canal. The differences between *P. macneili, P. heilprini, P. fusinoides,* and *P. gabbi* are minimal and are related to the height of the spire, inflation of the whorls, etc. From all of these *P. improcerus* differs in having by far the lowest spire, the smallest size, and the heaviest varices.

Other members of the group, such as *P. lychnia, P. mauryae* and *P. turbinelloides* are more scabrous; *P. gibsonsmithi,* which also occurs in the Cantaure Formation, is distinguished by its larger size, weaker varices, and more biconic outline.

Poirieria (Panamurex) lychnia
(Gardner)
Plate 10, figures 1, 2

Poirieria (Panamurex) lychnia (Gardner). VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 35, pl. 6, fig. 5; VOKES, 1972, Earth Science, v. 25, no. 3, p. 122, pl. 1, fig. 6.

Holotype: USNM 371853; height 25.5 mm, diameter 15 mm.

Type locality: USGS 2213, Chipola Formation; Chipola River, one mile [0.4 mi = 0.6 km] below Bailey's Ferry, Calhoun County, Florida (= TU 457).

Occurrence: Chipola Formation, Florida.

Figured specimens: Fig. 1, USNM 462690; height 27.6 mm, diameter (including spines) 15.7 mm; locality TU 950. Fig. 2, USNM 462691; height 11.7 mm, diameter 8 mm; locality TU 547. Additional localities: TU 459, 830, 1020, 1050, 1196.

Discussion: Poirieria (Panamurex) lychnia is closely related to a species that occurs in the Oligocene beds of Gaas, France. The latter has several names: *Fusus turbinelloides* Grateloup, 1833; *Turbinella muricina* Grateloup, 1847; and more recently *Murex (Poirieria) corniculatus* Vergneau, 1963. The French species occurs at almost every locality in the vicinity of Gaas, in beds that are considered to be both Early Oligocene (Stampian) at Lagouarde and Espibos, and Late Oligocene (Chattian) at Saint-Paul-les-Dax and Lesbarritz (see Dolin *et al.*, 1985, for a discussion of these localities).

The Early Oligocene occurrence makes this the oldest known species of *Panamurex,* slightly preceding the Middle Oligocene Byram Formation *P.(P.) macneili.* As may be seen from the examples figured here, this species, when worn (pl. 10, fig. 3), bears a great resemblance to *P. mauryae.* When unworn (pl. 10, fig. 4), as figured by Vergneau (1963, fig. 5), it bears a greater resemblance to *P. lychnia.* One can assume that this is due to the similar environment, which as described by Dolin *et al.* (1985, p. 9) was, like the Chipola Formation, a warm shallow coralline facies, rich in mollusks.

Presumably it is the European *P.(P.) turbinelloides* that gave rise to the Indian Ocean Recent species *P.(P.) hemmenorum* Houart and Muhlhauser, 1990, but there are no species of *Panamurex* presently known from the Old World in the strata between the two. Clearly there are some missing links that have yet to be discovered.

Poirieria (Panamurex) gibsonsmithi
Vokes, n. sp.
Plate 10, figures 5, 6

Description: Biconic shell with seven teleoconch whorls and a protoconch of one and one half rounded whorls. Axial ornamentation on first teleoconch whorl of nine angulate ridges, decreasing to seven per whorl on the third and succeeding whorls. Shoulder angles gradually developing into open spines, almost perpendicular to axis of shell. Varices low, rounded, ornamented only by spiral cords and one spine at the shoulder. Spiral ornamentation on early teleoconch whorls of three cords: one at shoulder, one immediately adjacent to suture and one midway between; a fourth soon added on shoulder ramp and then a fifth between the two main cords at the periphery. Body whorl with six or seven major cords and two or three smaller intercalary ones. Another two strong cords on siphonal canal. Except for spiral cords shell surface smooth. On the spiral cords on the siphonal canal small adaperturally directed open spinelets produced. Suture appressed, slightly sinuated by offset of varices on succeeding whorls. Aperture oval, inner lip wide, appres-

sed, smooth but with four or five elongate rugae on anterior half. Inner side of outer lip opening into the shoulder spine and marked with about nine lirae, corresponding to spaces between external spiral cords. Siphonal canal short, recurved at distal end, forming a small fasciole.

Holotype: NMB H 17385; height 26.6 mm, diameter 18.6 mm.

Type locality: NMB 17516, Cantaure Formation; Paraguaná Peninsula, Venezuela (= TU 1269).

Etymology of name: In honor of Mr. Jack Gibson Smith, formerly of Caracas, Venezuela, now of Surrey, England, who's extraordinary collection of Venezuelan fossil mollusks has been deposited in the Naturhistorisches Museum, Basel, Switzerland.

Occurrence: Cantaure Formation, Venezuela.

Figured specimens: Fig. 5, NMB H 17385 (holotype). Fig. 6, NMB H 17386 (paratype); height 9.6 mm, diameter 5.6 mm; locality same as holotype.

Discussion: In the Gibson Smith Collection at the Naturhistorisches Museum, Basel, Switzerland, there are eight specimens from the long known locality at "Casa Cantaure," Paraguaná Peninsula, Venezuela (see Jung, 1965), of a new species that is similar in general morphology to *P.(P.) lychnia* but differs in lacking the scabrous surface ornamentation of the latter species.

The combination of an appressed suture and shoulder spines directed perpendicularly to the axis gives the shell a marked biconic outline that readily distinguishes it from all other members of the Species Group. The spines on the siphonal canal are the least well developed in the Group, with the possible expection of the younger Caujarao Formation examples of *P. improcerus*, n. sp. (however, as noted above, this may be a function of poor preservation in the latter).

Poirieria (Panamurex) mauryae Vokes
Plate 10, figure 7

Poirieria (Panamurex) mauryae VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 36, pl. 6, fig. 8; VOKES, 1972, Earth Science, v. 25, no. 3, p. 122, pl. 1, fig. 7.

Holotype: USNM 646431; height 16.6 mm, diameter 9 mm.

Type locality: TU 458, Chipola Formation; east bank of Chipola River, just above mouth of Farley Creek (SW 1/4 Sec. 20, T1N, R9W), Calhoun County, Florida.

Occurrence: Chipola Formation, Florida.

Figured specimen: USNM 462693; height 15.8 mm, diameter 9.6 mm; locality TU 555. Additional localities: TU 459, 819, 998, 999, 1048, 1098, 1196.

Discussion: Poirieria (Panamurex) mauryae is found at almost every Chipola locality, occurring almost equally in all facies. Most examples are more or less abraded but well preserved specimens do show small spines at the shoulder and, more importantly, encircling the siphonal canal (pl. 10, fig. 7b).

Poirieria (Panamurex) gabbi Vokes
Plate 9, figures 7, 8

Poirieria (Panamurex) gabbi VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 39, pl. 7, fig. 2; VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 57, pl. 5, fig. 8.

Holotype: USNM 646084; height 24.7 mm, diameter 14.3 mm.

Type locality: USGS 8544, Gurabo Formation; right bank of Río Gurabo, about 150 meters above middle ford at Gurabo Adentro, Monte Cristi, Dominican Republic (= TU 1210).

Occurrence: Gurabo Formation, Dominican Republic.

Figured specimens: Fig. 7, USNM 375461; height 41.9 mm, diameter 22.4 mm; locality TU 1412. Fig. 8, PRI 33042; height 27.9 mm, diameter 17.9 mm; locality TU 1210. Additional locality: TU 1211.

Discussion: Poirieria (Panamurex) gabbi was based upon a single specimen collected by Vaughan *et al.* (1921) in their reconnaisance of the Dominican Republic. Our work there yielded only another five specimens, all but one (pl. 9, fig. 7) from the vicinity of the type locality.

Poirieria (Panamurex) carnicolor (Clench and Pérez Farfante)
Plate 10, figure 8

Poirieria (Panamurex) carnicolor (Clench and Pérez Farfante). VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 46, pl. 6, fig. 6.

Panamurex carnicolor (Clench and Pérez Farfante). FAIR, 1976, The Murex Book, p. 30, not pl. 15, fig. 195 (= *Acanthotrophon* sp.).

Holotype: MCZ 7305; height 20 mm, diameter 10 mm (*fide* Clench and Pérez Farfante, 1945, p. 48; specimen not found).

Type locality: *Blake* Station 273, off Barbados, Lesser Antilles, in 103 fathoms [184 meters].

Occurrence: Recent only, Lesser Antilles.

Figured specimen: USNM 679266; height 28 mm, diameter 16 mm; locality *Oregon* Station 5070, off Nevis, Leeward Islands, in 50 to 60 fathoms [91-110 meters].

Discussion: Radwin and D'Attilio (1976, p. 31) considered *P. carnicolor* a "name of dubious identity," their reason being: "We have examined the supposed holotype of *P. carnicolor* on loan from the Museum of Comparative Zoology, and have concluded that it does not represent the specimen figured with the original description; indeed, it may not even represent the same species. The specimen figured by Vokes [1970] as this species is not from the type lot, although it does resemble the original figure."

Examination of the "holotype" in the MCZ collections shows that they are absolutely correct. The specimen is not *P. carnicolor;* it is neither the shell figured nor described. It is the specimen figured by Fair (1976, pl. 15, fig. 195) and is, as Radwin and D'Attilio indicated, not only a different species but a different genus. It is a species of the muricopsine genus *Acanthotrophon* and will be treated in a future part of this series.

A search of the MCZ collections did not turn up the true holotype. It was hoped that a second specimen, stated by Clench and Pérez Farfante (1945, p. 49) to be in the U.S. National Museum collections (USNM 87082, from Station 156, off Montserrat), might prove to be the holotype. Unfortunately, that shell (figured by M. Smith, 1953, pl. 12, fig. 4) is a much less ornamented specimen, although there is no question it is the same species as the figured holotype. So, for the present, the holotype is "lost." But this does not prevent identification of the species, as Radwin and D'Attilio implied.

The type of *"Murex" interserratus* Sowerby, 1879, the species with which *P. carnicolor* was originally confused, has been located in the Muséum National d'Histoire Naturelle, Paris. It is figured by Houart (1982, text-fig. c) and D'Attilio and Myers (1985, text-fig. 1), who all assign it to the genus *Murexsul.* It is similar to *P. carnicolor* in the numerous spinose varices and the somewhat scabrous surface; otherwise there is no more than a familial relationship. The type locality, which was unknown, is Japan. *Murex interserratus* has two other invalid synonyms: *Murex ednae* M. Smith, 1940, and *Murexsul zonatus* Hayashi and Habe, 1965.

Leal, in his study of the gastropods from the Brazilian oceanic islands (1991, p. 137), included a form as "*Panamurex* sp. 1, which he stated had been tentatively identified by Houart (in press) as *Panamurex carnicolor* but which he believed to be a different species. In Houart's published paper the species was treated as *Murexsul*

PLATE 11

Figures Page

1-4. *Poirieria (Panamurex) rutschi* Vokes, n. sp. 52
1. (X 2) NMB H 17387 (holotype); height 21.8 mm, diameter 15.2 mm.
2. (X 2) NMB H 17388 (paratype A); height 23.4 mm, diameter 14 mm.
3. (X 2) NMB H 17389 (paratype B); height (incomplete) 17.4 mm, diameter 12.1 mm.
4. (4a X 3, 4b X 10) NMB H 17390 (paratype C); height 15.5 mm, diameter 8.7 mm.
Locality of all: NMB 17531, Venezuela; Punta Gavilán Formation.
5. *Poirieria (Panamurex) recticanalis* (Weisbord) (X 3) 53
NMB H 17391; height 17 mm, diameter 10 mm.
Locality: Quebrada Mare Abajo, Dto. Federal, Venezuela; Mare Formation.
6. *Poirieria (Panamurex) velero* Vokes (X 3) 53
LACM-AHF 1407 (holotype); height 14.2 mm, diameter 8 mm.
Locality: *Velero* III Stations A-13-39 and A-14-39, Cabo de la Vela, Guajira Peninsula, Colombia, in 10-22 fathoms [18-40 meters]; Recent.
7, 8. *Poirieria (Panamurex) eugeniae* Vokes, n. sp. (X 3) 54
7. USNM 860292 (holotype); height 19.2 mm, diameter 10.5 mm.
Locality: Off Santa Marta, Colombia, in 50 meters; Recent.
8. USNM 860293 (paratype); height 17.3 mm, diameter 9 mm.
Locality: Off Cabo de la Vela, Colombia, in 20 meters; Recent.

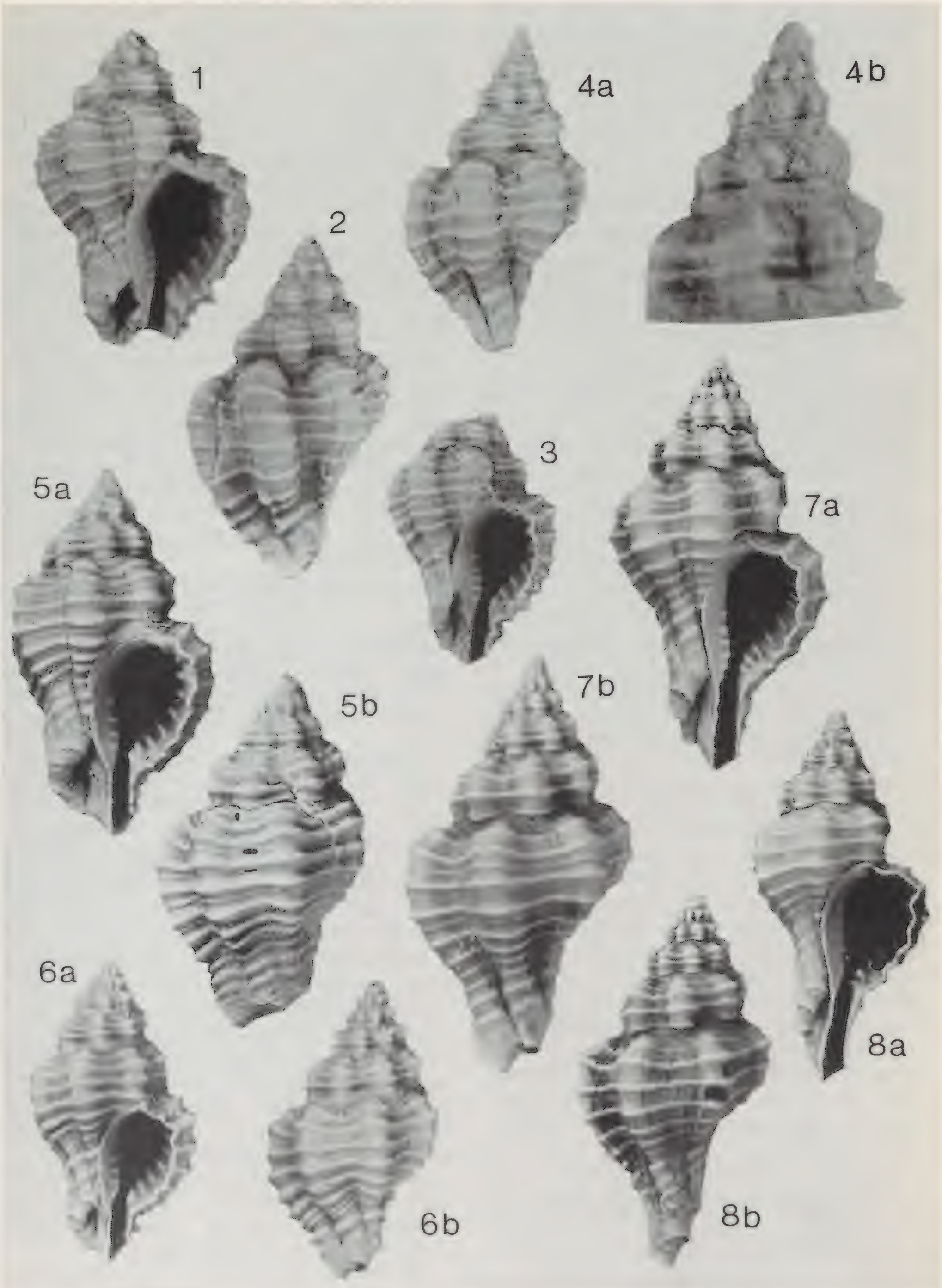

PLATE 11

sp. (1991a, p. 31, figs. 8, 30, 31) with the observation: The largest of the Brazilian specimens is 5.2 mm long . . . Examination of adult specimens is necessary for positive identification." On the basis of his illustrations the assignment to *Murexsul* is preferable to *Panamurex*.

Species Group 3: *Poirieria (Panamurex) velero*

Discussion: The members of this Species Group are the least ornamented of the subgenus. They have neither a labral tooth nor spines encircling the siphonal canal. The species included herein are similar in many ways to the Recent species of the genus *Calotrophon* and, for this reason, Radwin and D'Attilio (1976) assigned the Recent representative of this line to *Calotrophon*. I do not doubt that the two lines are closely related; the earliest members of *Calotrophon* still carry the rugae on the columellar lip that characterize *Panamurex*. The radulae of *Calotrophon turritus* (Dall), type of the genus, and of *C. ostrearum* (Conrad) (both figured by McLean and Emerson, 1970, text-figs. 8 and 15, respectively) are identical to that of *Poirieria (Panamurex) velero* (figured by Radwin and D'Attilio, 1976, text-fig. 14), which, in turn, is identical to that of *Poirieria (Paziella) pazi* (figured by Radwin and D'Attilio, 1976, text-fig. 50).

Radwin and D'Attilio (1976, p. 32) suggested that *Calotrophon* was a direct descendant of a Miocene *Panamurex* form, which, as they state: "explains the absence of *Calotrophon* in earlier periods and the apparent paucity of Recent *Panamurex* species." If *P. velero* stood alone in time as the only member of this particular Species Group, I would accept it as a strange member of *Calotrophon*, but it is just one of a line of species that probably originated with the Chipola species *P.(P.) mauryae* and has survived in the southern Caribbean until today.

POIRIERIA (PANAMUREX) RUTSCHI
Vokes, n. sp.
Plate 11, figures 1-4

Description: Massive shell with seven teleoconch whorls and protoconch of one and one half rounded whorls, the first whorl at an angle to remainder of shell. Axial ornamentation on first teleoconch whorl of nine rounded ridges, decreasing to six on third and succeeding whorls and becoming heavy, rounded, indistinct varices. Adapertural faces of varices marked by small spines directed forward from the spiral cord at the base of the body whorl and that one on the siphonal canal. No other spines; varices ornamented only by crossing of spiral cords. Spiral ornamentation on early teleoconch whorls of three cords: one at shoulder, one immediately adjacent to suture and one between; a fourth added later on shoulder ramp. Body whorl with six or seven major cords, plus one major cord on siphonal canal, separated from body whorl by a smaller cord. Except for spiral cords, shell surface smooth. Suture on early whorls appressed but becoming increasingly impressed and sinuated by varices. Aperture oval; inner lip wide, appressed, smooth but with five elongate rugae on anterior half. Inner side of outer lip with about seven lirae, corresponding to spaces between external spiral cords. Siphonal canal short, very broad, with deep fasciole.

Holotype: NMB H 17387; height 21.8 mm, diameter 15.2 mm.

Type locality: NMB 17531, Punta Gavilán Formation; Punta Gavilán, Edo. de Falcón, Venezuela.

Etymology of name: In honor of Rolf F. Rutsch, author of many papers on Caribbean fossil mollusks, in particular those of the Punta Gavilán Formation, type locality of this new species.

Occurrence: Punta Gavilán Formation, Venezuela.

Figured specimens: Fig. 1, NMB H 17387 (holotype). Fig. 2, NMB H 17388 (paratype A); height 23.4 mm, diameter 14 mm. Fig. 3, NMB H 17389 (paratype B); height (incomplete) 17.4 mm, diameter 12.1 mm. Fig. 4, NMB H 17890 (paratype C); height 15.5 mm, diameter 8.7 mm. Locality of all same as the holotype.

Discussion: In the Gibson Smith Collection at the Naturhistorisches Museum, Basel, Switzerland, there are several examples of a new species from Punta Gavilán, Venezuela, which is transitional between the group of *P.(P.) laccapoia*, with a labral tooth, and the group of *P.(P.) velero*, which lacks the labral tooth. The labral tooth in *P. rutschi* is almost vestigial but is important for it reinforces my belief that the species of *Panamurex* with and without the tooth are sufficiently near in relationship to be included in one subgenus.

There is a superficial resemblance to another Venezuelan species, *P.(P.) recticanalis*, but the new species differs in the

more attenuated spire, in addition to the presence of the labral tooth, which is not developed in the latter.

Unfortunately the material at Punta Gavilán is silicified and not very well preserved. Thus it was necessary to use several specimens to view all of the morphological features. For this reason there are three figured paratypes, in addition to the holotype.

POIRIERIA (PANAMUREX) RECTICANALIS
(Weisbord)
Plate 11, figure 5

Latirus (Polygona) recticanalis WEISBORD, 1962, Bulls. Amer. Paleontology, v. 42, no. 193, p. 356, pl. 30, figs. 17, 18.

Not *Panamurex recticanalis* (Weisbord). PETUCH, 1987, New Caribbean Moll. Faunas, p. 89, pl. 20, figs. 4, 5 [= *Poirieria (Panamurex) eugeniae*, n. sp.].

Panamurex recticanalis (Weisbord). LYONS, 1991, Bull. Florida Mus. Nat. Hist., Biol. Sci., v. 35, no. 3, p. 198.

Holotype: PRI 26254; height 15 mm, diameter 8.7 mm.

Type locality: Playa Grande Formation (Maiquetia Member); Quebrada Las Bruscas, about 125 meters upstream from junction with Quebrada Las Pailas, Dto. Federal, Venezuela.

Occurrence: Playa Grande and Mare formations, Venezuela.

Figured specimen: NMB H 17391; height 17 mm, diameter 10 mm; locality, Quebrada Mare Abajo, Dto. Federal, Venezuela.

Discussion: Poirieria (Panamurex) recticanalis, which is closely related to the Recent *P. velero*, was originally described as a *Latirus* and, thus, was overlooked in my original discussion of *Panamurex*. Some years ago, Mr. Jack Gibson Smith, then of Caracas, Venezuela, advised me that the species should be referred to *Panamurex* and loaned me several specimens collected at the type locality of Weisbord's Mare Formation (locality W-14 of Weisbord, 1962, p. 11), one of which is figured here (pl. 11, fig. 5).

Since that time Petuch, who received the same information from Mr. Gibson Smith (see Petuch, 1981, p. 308), figured a Recent specimen from the "Gatunian Relict Pocket" of northern Venezuela, which he referred to *P. recticanalis*. It is not the same species and is described below as *P. eugeniae*.

The Recent *P. velero* is morphologically similar to *P. recticanalis* and there is some reason to place the two in synonymy. However, there are consistent differences. The older *P. recticanalis* is larger for the same number of whorls; the two figured specimens are approximately the same size, but the specimen of *P. velero* (pl. 11, fig. 6) has one more whorl at the same size. In addition, *P. recticanalis* always has a secondary cord between each of the major spiral cords but *P. velero* does not (*P. eugeniae* also has these secondary cords). Therefore, though the two forms are closely related, they are not placed in synonymy.

Most early workers considered the beds of the Cabo Blanco Group to be of Quaternary age (see Weisbord's discussion, 1962, pp. 29-33) but, on the basis of percentage of living species, Weisbord concluded that the beds ranged from Late Miocene at the bottom (Catia Member, Playa Grande Formation) to Pleistocene (Abisinia Formation). Later work utilizing planktic foraminifers has determined that the Playa Grande is Pleistocene also. Unfortunately, the exposures of the Cabo Blanco Group have been destroyed in the expansion of the Maiquetia (Caracas) International Airport (see Gibson Smith, 1971), another classic fossil collecting locality lost to "progress."

POIRIERIA (PANAMUREX) VELERO (Vokes)
Plate 11, figure 6

Poirieria (Panamurex) velero VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 47, text-fig. 1.

Calotrophon velero (Vokes). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 31, pl. 23, fig. 5; DE JONG and COOMANS, 1988, Stud. Fauna Curaçao and Caribbean Isl., no. 214, p. 73, pl. 36, fig. 396.

Panamurex velero (Vokes). FAIR, 1976, The Murex Book, p. 85, pl. 15, fig. 199 (holotype); PETUCH, 1987, New Caribbean Moll. Faunas, p. 189, pl. 19, figs. 10, 11.

Holotype: LACM-AHF 1407 (not 1406, as originally cited); height 14.2 mm, diameter 8 mm.

Type locality: *Velero* III Stations A-13-39 and A-14-39, Cabo de la Vela, Guajira Peninsula, Colombia, in 10-22 fathoms [18-40 meters].

Occurrence: Recent only, coast of northern South America, from Santa Marta, Colombia, to Curaçao, Netherland Antilles.

Figured specimen: LACM-AHF 1407 (holotype).

Discussion: Radwin and D'Attilio (1976, p. 31) assigned *P. velero* to the genus *Calotrophon*, on the basis of their observation that "an examination of several dozen specimens of *C. ostrearum* from Boca Ciega, Florida, has resulted in the discovery that fully one-third of the specimens had more or less well-marked denticles at the anterior of the columella," and they believed that this character is, therefore, of questionable value in assigning species to one or the other of these genera.

I have not examined any specimens from Boca Ciega, but in the hundreds of fossil and Recent examples of *C. ostrearum* from other localities, except for the oldest fossil examples (those from the earliest "Pinecrest Beds"), I have seen no more than a single small denticle at the very neck of the siphonal canal (well shown in Vokes, 1976b, pl. 5, fig. 8a; refigured here pl. 19, fig. 8); this cannot be considered equivalent to the several strong rugae marking the columellar wall seen in the species of *Panamurex*.

But, columellar rugae are just one of a set of characteristics inherited from a line of ancestors going far back in geologic time. That *Calotrophon* branched off the *Panamurex* line is not questioned, with the earliest species *C. phagon* being a contemporary of *P.(P.) mauryae*, and the two lines have continued on parallel courses since the Early Miocene. To place both lineages in the same genus masks (and ignores) the geologic history of the two groups.

From the evidence at hand, *P. velero* is relatively abundant only in a limited area near the Guajira Peninsula, Colombia. De Jong and Coomans (1988, p. 73) report about 100 specimens from Aruba, as well as some from Curaçao and Santa Marta, Colombia. The apparent limited distribution may be the result of the small size of the species (specimens rarely exceed 15 mm) and they may be overlooked easily by collectors.

Poirieria (Panamurex) eugeniae
Vokes, n. sp.
Plate 11, figures 7, 8

Panamurex recticanalis (Weisbord). PETUCH, 1987, New Caribbean Moll. Faunas, p. 89, pl. 20, figs. 4, 5 (not of Weisbord).

Description: Shell with protoconch of one and one-half bulbous whorls, ended by onset of or-

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PLATE 12

Figures

Page
1-3. *Aspella castor* Radwin and D'Attilio 57
1. (X 5) USNM 663525 (holotype); height 13 mm, diameter 5.9 mm.
Locality: Puerto Rico; Recent.
(Photograph courtesy of G.E. Radwin and A. D'Attilio)
2. (X 6) USNM 323895; height 9.1 mm, diameter 4.3 mm.
Locality: TU 1227A, Dominican Republic; Gurabo Formation.
3. (X 8) MORG 23.763; height 5.8 mm, diameter 2.7 mm.
Locality: Abrolhos Archipelago, Brazil; Recent.
4, 5. *Aspella senex* Dall (X 4) 58
4. USNM 739566; height 14 mm, diameter 8 mm.
Locality: "Hourglass" Station L, about 85 miles [137 km] off Ft. Myers, Florida, in 27 fathoms [49 meters]; Recent.
5. USNM 647439; height 14.6 mm, diameter 6.4 mm.
Locality: TU 759, Florida; Bermont Formation.
6, 7. *Aspella cryptica* Radwin and D'Attilio 58
6. (X 8) SDSNH 62608 (holotype); height 6.2 mm, diameter 2.8 mm.
Locality: Itapoan [Itapuã], Bahia, Brazil; Recent.
7. (X 6) MORG 21.024; height 9 mm, diameter 4 mm.
Locality: Guaratiba Alcobaça, Bahia, Brazil (*ex* pisce); Recent.
8, 9. *Aspella morchi* Radwin and D'Attilio (X 8) 59
8. SDSNH 62609 (holotype); height 6.6 mm, diameter 3.3 mm.
Locality: Natal Bay, Rio Grande do Norte, Brazil; Recent.
9. MORG 22.616; height 6.5 mm, diameter 3.3 mm.
Locality: Ilha do Farol, Atol das Rocas [off Rio Grande do Norte], Brazil; Recent.

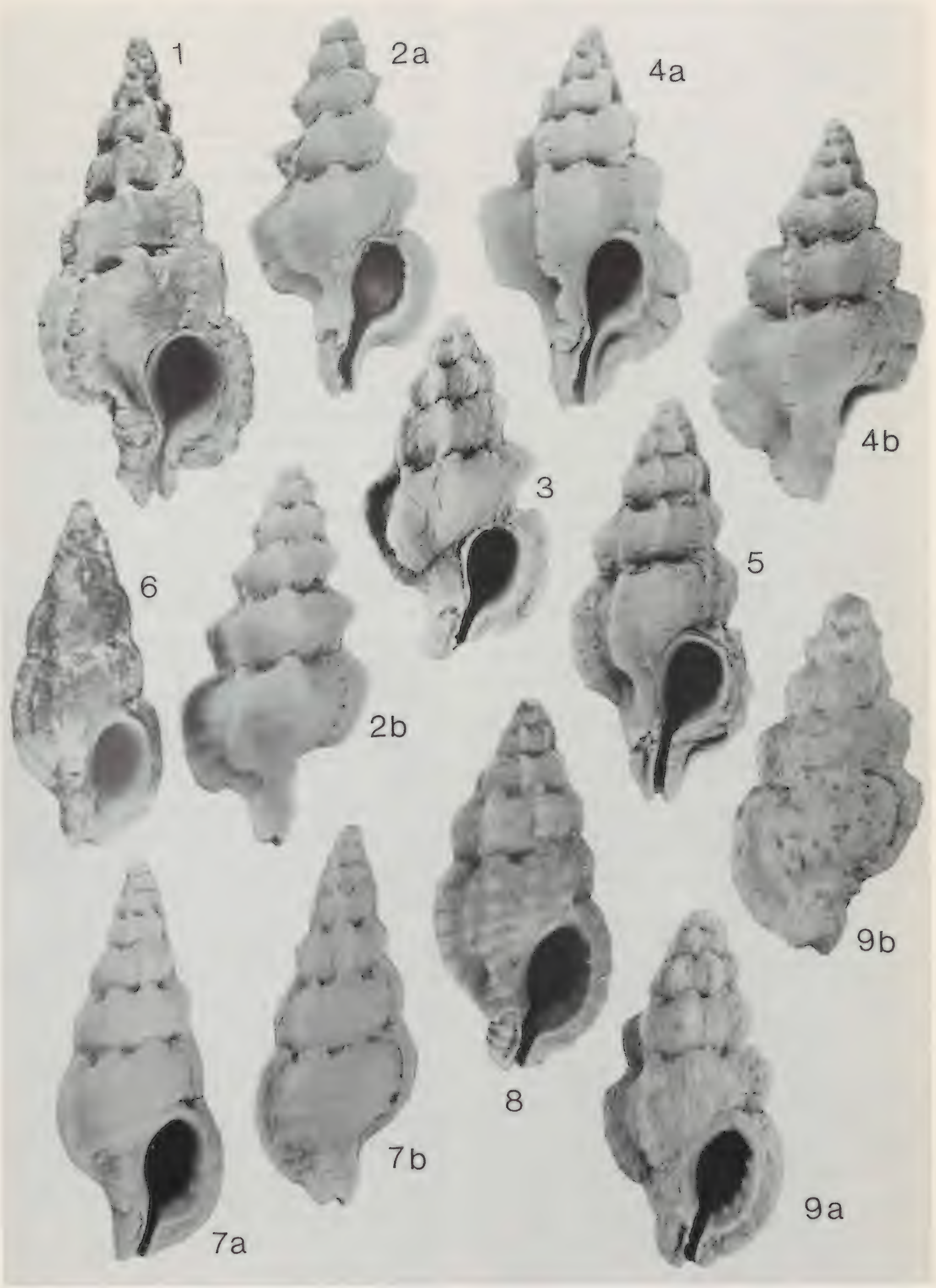


PLATE 12

namentation, no marked terminal varix; five teleoconch whorls in adult. Axial ornamentation on early whorls of teleoconch of first nine, then eight swollen ridges, having small open spines on each at the shoulder; gradually deceasing to six per whorl and losing the spines. On later whorls the axial ridges showing little varicial break, best seen at anterior end of siphonal canal. Surface of shell almost smooth except for growth lamellae anterior to suture. Spiral ornamentation on all whorls except last consisting of three strong cords, one at shoulder, one at suture, and one between; better developed across axial ridges. On about third teleoconch whorl a secondary cord appearing on shoulder ramp and by fifth teleoconch whorl secondary cords developed between each of the four posteriormost major spiral cords. On body whorl five major cords, plus the secondaries on shoulder and between posterior major cords; an additional four smaller cords on siphonal canal. Suture sigmoidal, undulated by axial ridges. Aperture oval, inner side of outer lip with about nine strong lirae, corresponding to spaces between major spiral cords. Columellar lip appressed at posterior end, free-standing at anterior end, with five rugae distributed over anterior half. Siphonal canal moderately long, recurved at distal end, forming small siphonal fasciole. Color cream, with darker lines topping the major spiral cords; a light frosting of intritacalx, evidently easily removed, none of type lot possessing more than traces.

Holotype: USNM 860292; height 19.2 mm, diameter 10.5 mm.

Type locality: Off Santa Marta, Colombia, in 50 meters.

Etymology of name: In honor of Eugenia I. Wright, Phoenix, Arizona, who provided the type specimen and who, over the years, has been extremely generous with specimens for illustration or comparison.

Occurrence: Recent only, northern South America, from Santa Marta, Colombia, to Golfo de Venezuela (*fide* Petuch, 1987).

Figured specimens: Fig. 7, USNM 860292 (holotype). Fig. 8, USNM 860293 (paratype); height 17.3 mm, diameter 9 mm; locality, off Cabo de la Vela, Colombia, in 20 meters.

Discssion: Although *P.(P.) eugeniae* occurs in the same area and depth as the congeneric *P. velero,* the two are easily separated. The new species is larger; at the same number of whorls it is about one-third larger than *P. velero* (pl. 11, figs. 6 and 7 both have five teleoconch whorls) and is more elongate, with a higher spire and longer siphonal canal. The spiral ornamentation in the new species is like that of the older *P. recticanalis,* with a secondary cord between each pair of major spiral cords, unlike *P. velero,* which has only the major cords. The holotype and one paratype have five columellar rugae in contrast to the four that seem to be constant in *P. velero* and *P. recticanalis.*

All three species are similar, and *P. recticanalis* presumably is ancestral to both living forms. Thus, *P. velero* is like its ancestor in the shorter outline and the four rugae; *P. eugeniae* is like its ancestor in retaining the intermediate spiral cords. Of the three, *P. recticanalis* is of median size; *P. velero* is smaller, *P. eugeniae* is larger.

The type lot consists of four specimens: the holotype, paratype, and one specimen in my collection; plus the specimen figured by Petuch (1987, pl. 20, figs. 4, 5). The latter shows well the darker color lines topping the spiral cords, the same pattern seen in the fossil species *P. gatunensis* and *P. fusinoides.*

Genus ASPELLA Mörch, 1877

Aspella MÖRCH, 1877, Malak. Blatter, v. 24, p. 24.

Type species: *Ranella anceps* Lamarck, 1822, by monotypy.

Discussion: The exact identity of *Ranella anceps* Lamarck, 1822, type of the genus *Aspella,* has been a problem since first described. In earlier times most species of *Aspella* were referred to "*anceps.*" Radwin and D'Attilio (1976, p. 21) discussed the problem, noting that the major distinguishing feature of these similar shells is the intritacalx, the thick deciduous layer so characteristic of the group as a whole. In their opinion, when beachworn (as is the type specimen of *Ranella anceps*), these shiny smooth specimens are virtually unidentifiable. There are, however, differences in the overall outline of the shell.

In attempting to sort out the various nominal species of *Aspella,* Radwin and D'Attilio discovered seven new species, which they named in an appendix to their book (1976, pp. 219-228), stating "it is likely that whatever Lamarck's *A. anceps* actually was has been treated herein under the name of one of the 11 species we have included, and the name is probably best considered a *nomen dubium*" (1976, p. 21).

Based on Kiener's illustration (1842, pl. 4, fig. 2) of Lamarck's species, I originally

(Vokes, 1975, p. 125) considered the South African *A. acuticostata* Turton, 1932, as the same species. Subsequently, Winston Ponder, of the Australian Museum, located Lamarck's type specimen in the Geneva Museum and it is not quite as narrow a shell as *A. acuticostata*. After Radwin and D'Attilio's treatment, I attempted (Vokes, 1985a, p. 431) to determine which of the possible contenders was the "real" *Aspella anceps* and concluded that it was *A. platylaevis* Radwin and D'Attilio, which has the requisite slender shape, the relatively large (14 mm) size, and the widest distribution (known from Western Australia to French Polynesia and the Philippine Islands). But it also could be *A. ponderi* Radwin and D'Attilio, moderately common in Western Australia, from whence a number of other Lamarck species come (e.g., *Murex acanthopterus, M. secundus,* and *M. fimbriatus* [= *planiliratus* Reeve]). Nevertheless, as Radwin and D'Attilio noted (1976, p. 21), whichever species is *A. anceps*, the generic concept remains unchanged, so similar are all the species.

When all forms of *Aspella* were lumped into "*anceps*" the group was very small. In 1975 there was a total of five described Recent species worldwide; but, I noted then that there were several species (seven, it turned out) soon to be described by Radwin and D'Attilio. Later another three Indo-Pacific species were described by Houart, and one additional eastern Pacific species by me. Thus, in less than 20 years the described species in the genus has increased from five to 16, plus another known but undescribed one.

The geologic history of the genus *Aspella* begins in the Oligocene of France. In the New World no species of *Aspella* are known before the Early Pliocene, but there are eight living species (four in the western Atlantic, four in the eastern Pacific). In addition, there are eight Indo-Pacific species, and one in the Mediterranean. Barash and Danin (1972, p. 312, fig. 8) cited *Aspella anceps* as an Indo-Pacific species that has migrated through the Suez Canal. According to their records, "*A. anceps*" has been known in the Mediterranean since 1905 but their figured specimen does not match any known Indo-Pacific species and, instead of being a migrant, almost certainly is endemic to the Mediterranean area.

Aspella castor Radwin and D'Attilio
Plate 12, figures 1-3

Aspella castor RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 219, pl. 28, fig. 1, text-figs. 158 (shell), 159 (intritacalx), 160 (radula); VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 212, pl. 1, fig. 8 (holotype); VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 58, pl. 7, fig. 12.

Aspella senex Dall. RIOS, 1985, Seashells of Brazil, p. 87, pl. 31, fig. 382; HOUART, 1991, Nautilus, v. 105, no. 1, p. 27; LEAL, 1991, Mar. Prosobranch Gast. Oceanic Islands Brazil, p. 143 (not of Dall).

Holotype: USNM 663525; height 13 mm, diameter 5.9 mm.

Type locality: Puerto Rico.

Occurrence: Gurabo Formation, Dominican Republic. Recent, Florida, Puerto Rico, Virgin Islands, and Abrolhos Archipelago, Brazil.

Figured specimens: Fig. 1, USNM 663525 (holotype; photograph courtesy of G.E. Radwin and A. D'Attilio). Fig. 2, USNM 323895; height 9.1 mm, diameter 4.3 mm; locality TU 1227A. Fig. 3, MORG 23.763; height 5.8 mm, diameter 2.7 mm; locality, Abrolhos Archipelago, Brazil.

Discussion: Radwin and D'Attilio (1976, p. 219) separated *Aspella castor* from *A. senex* on the basis that the new species is more elongate. This holds true for Recent examples of the two species (compare pl. 12, figs. 1 and 4), but with fossil specimens of *Aspella,* the varical extensions formed by the intritacalx cause problems for they are invariably lost in the fossil state. Thus, a fossil *A. senex* is much narrower than a living one (compare pl. 12, figs. 4 and 5) and conversely, a fossil specimen of *A. castor* is much wider than a fossil *A. senex*.

In the Gurabo Formation, Dominican Republic, we have collected four examples of *A. castor,* all from one unusual locality where shallow-water reefal material has been washed downslope by gravity flow into deep-water Gurabo clays. These clays have been dated with planktic foraminifera as Zone N.18, or basal Pliocene. Thus, these specimens are the oldest known species of *Aspella* in the New World.

Aspella castor was described originally from Puerto Rico and the Virgin Islands. In the collections of the Academy of Natural Sciences, Philadelphia, a juvenile specimen (ANSP 36335) from Tampa Bay,

Florida, can be referred to this species. If the locality is correct, this extends the range into the Gulf of Mexico.

Houart (1991a, p. 27) and Leal (1991, p. 143) recorded *Aspella senex* from Vitória Bank, Espírito Santo, Brazil; however, neither figured the specimen. As Houart noted, Rios (1985, p. 87) had previously reported this species from the Abrolhos Islands. The specimens from the Abrolhos (MORG 23.763 and 26.855, seven in all; see pl. 12, fig. 3) are all tiny (under 6 mm) but otherwise seem referable to *A. castor*. They are certainly close to it but, given the small size, they may prove to be a different species.

Aspella senex Dall
Plate 12, figures 4, 5

Aspella senex Dall. VOKES, 1975, Tulane Stud. Geol. Paleont., v. 11, no. 3, p. 132, pl. 1, figs. 1-4, 7; RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 25, pl. 1, figs. 1, 2; FAIR, 1976, The Murex Book, p. 76, pl. 16, fig. 209.

Not *Aspella senex* Dall. RIOS, 1985, Seashells of Brazil, p. 87, pl. 31, fig. 382; HOUART, 1991, Nautilus, v. 105, no. 1, p. 27; LEAL, 1991, Mar. Prosobranch Gast. Oceanic Islands Brazil, p. 143 (= *A. castor*).

Holotype: USNM 163959; height 9.5 mm, diameter 4 mm.

Type locality: Caloosahatchee or Bermont Formation; Shell Creek, Cleveland County, Florida (= TU 539A/B).

Occurrence: Fruitville (= "Pinecrest Beds"), Caloosahatchee, and Bermont formations, Florida; Waccamaw Formation, South Carolina. Recent, from North Carolina to Veracruz, Mexico.

Figured specimens: Fig. 4, USNM 739566; height 14 mm, diameter 8 mm; locality "Hourglass" Station L, about 85 miles [137 km] off Ft. Myers, Florida, in 27 fathoms [49 meters]. Fig. 5, USNM 647439; height 14.6 mm, diameter 6.4 mm; locality TU 759. Additional localities: TU 79, 558.

Discussion: Aspella senex remains as rare today as it was in 1975. The beds at the APAC quarry in Sarasota, Florida (TU 1000), as well as those along the Kissimmee River (TU localities 728, 729, 730), are now referred to the Fruitville Formation rather than the Pinecrest Beds (Waldrop and Wilson, 1990), but we have no new material from either area. In the collections of Richard E. Petit, North Myrtle Beach, South Carolina, there are a few examples of *A. senex* from the Waccamaw Formation (TU 558), although we have not collected any personally.

Houart (1991a, p. 27), Leal (1991, p. 143) and Rios (1985, p. 87) have reported *Aspella senex* from the Abrolhos Islands, Brazil. Examination of material in the collections of the Museu Oceanográfico, Rio Grande do Sul, reveals that the specimens are better assigned to *A. castor*. The single dead specimen reported from the Vitória Seamount by Houart and Leal (*ibid.*) is assumed to be the same.

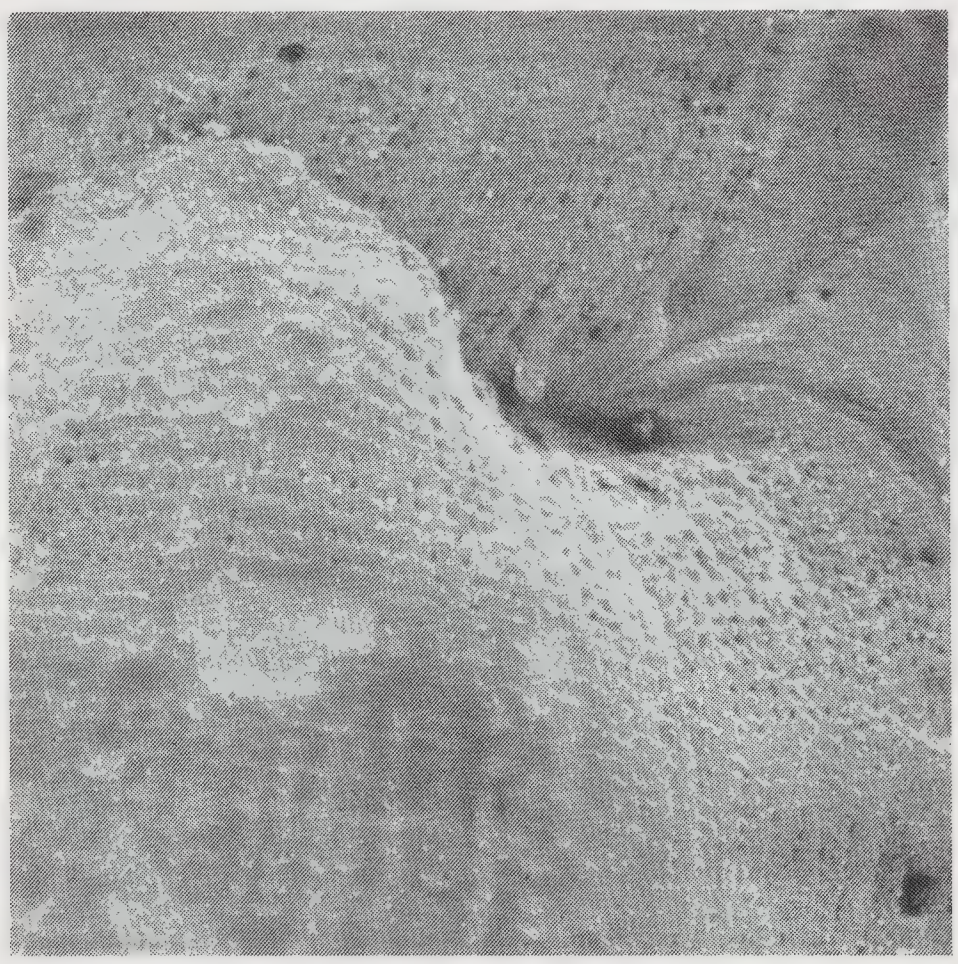
Aspella cryptica
Radwin and D'Attilio
Plate 12, figures 6, 7; text-figure 3

Aspella anceps (Lamarck). RIOS, 1970, Coastal Brazilian Seashells, p. 83 (in part); RIOS, 1975, Brazilian Mar. Moll. Icon., p. 87 (in part), not pl. 25, fig. 357 (= *A. morchi*); RIOS, 1985, Seashells of Brazil, p. 87 (in part), not pl. 31, fig. 379 (= *A. morchi*) (not of Lamarck).

Aspella cryptica RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 220, pl. 1, fig. 10, text-figs. 161 (shell), 162 (intritacalx); VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 212, pl. 1, fig. 10 (holotype); RIOS, 1985, Seashells of Brazil, p. 87, pl. 31, fig. 380 (holotype).

Holotype: SDSNH 62608; height 6.2 mm, diameter 2.8 mm.

Type locality: Itapoan [Itapuã], Bahia, Brazil.



Text-figure 3. *Aspella cryptica* Radwin and D'Attilio; MORG 20.989; height 6.2 mm, diameter 2.3 mm; locality, Itapuã, Bahia, Brazil. Detail of intritacalx (X 70).

Occurrence: Recent only, northern Brazil.

Figured specimens: Fig. 6, SDSNH 62608 (holotype; photograph courtesy of G.E. Radwin and A. D'Attilio). Fig. 7, MORG 21.024; height 9 mm, diameter 4 mm; locality, Guaratiba Alcobaça, Bahia, Brazil (*ex* pisce).

Discussion: Rios (1970, p. 83; 1975, p. 87, pl. 25, fig. 357) reported "*Aspella anceps*" from several stations in northern Brazil. Subsequently (1985, p. 87) he noted that *A. anceps* is an Indo-Pacific species and does not occur in Brazil, but he did not identify the shell he figured under this name. I examined the specimens he assigned to *A. anceps* and most are *A. morchi,* but one (Station 29, Paripueira, Alagoas) is *A. cryptica.* His figured specimen (Station 6, off Pará River) appears to be *A. morchi.*

Kaicher (1978, no. 1566) has figured an example from the Abrolhos Archipelago, Brazil, which is considerably larger than the holotype (estimated height 14 mm, if complete). Most specimens in the Museu Oceanográfico, Rio Grande do Sul, are about 7 mm; the specimen figured here (pl. 12, fig. 7) is the largest.

ASPELLA MORCHI
Radwin and D'Attilio
Plate 12, figures 8, 9; text-figure 4

Aspella anceps (Lamarck). RIOS, 1970, Coastal Brazilian Seashells, p. 83 (in part); RIOS, 1975, Brazilian Mar. Moll. Icon., p. 87 (in part), pl. 25, fig. 357; RIOS, 1985, Seashells of Brazil, p. 87 (in part), pl. 31, fig. 379 (not of Lamarck).

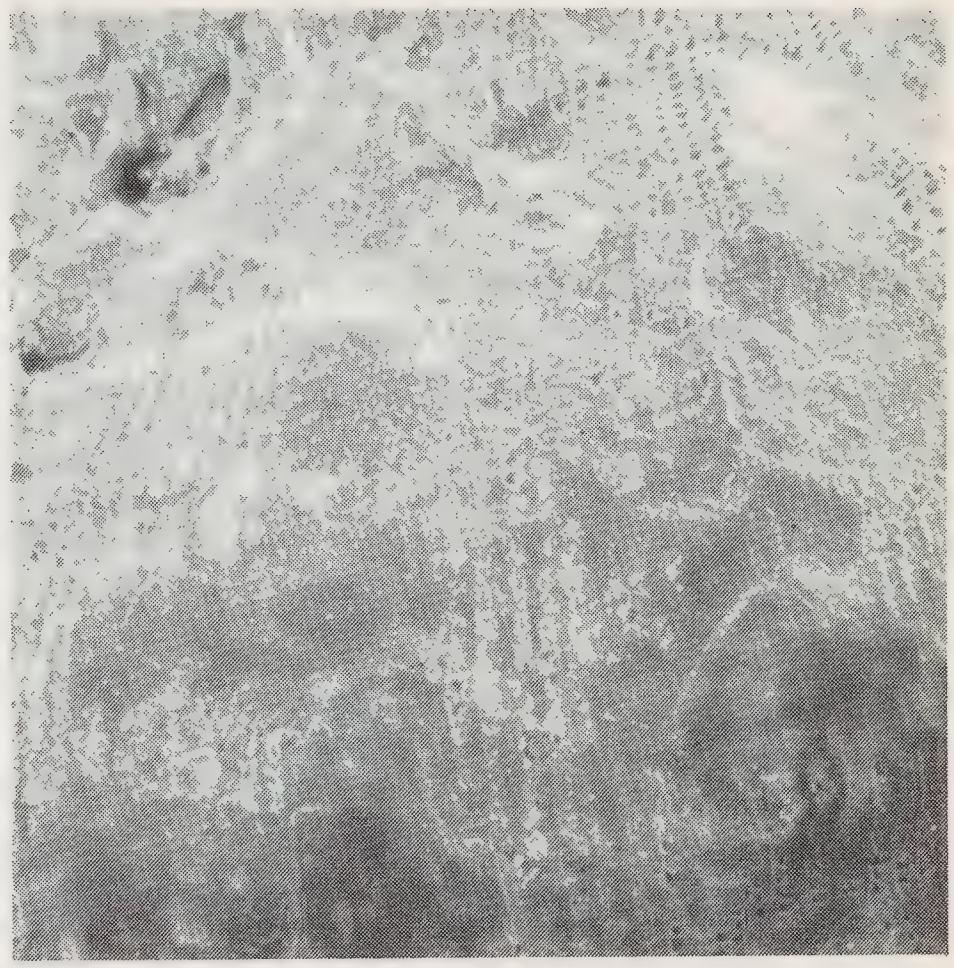
Aspella morchi RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 223, pl. 1, fig. 9, text-figs. 166 (shell), 167 (intritacalx); VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 212, pl. 1, fig. 12 (holotype); RIOS, 1985, Seashells of Brazil, p. 87, pl. 31, fig. 381 (holotype); HOUART, 1991, Nautilus, v. 105, no. 1, p. 27, text-figs. 9, 10 (protoconch), 29 (shell); LEAL, 1991, Mar. Prosobranch Gast. Oceanic Islands Brazil, p. 143, pl. 1, fig. L (shell); pl. 18, figs. J (juvenile shell), K (protoconch), L (intritacalx).

Holotype: SDSNH 62609; height 6.6 mm, diameter 3.3 mm.

Type locality: Natal Bay, Rio Grande do Norte, Brazil (Leal, 1991, p. 143, has observed that "there is no such thing as a bay in Natal"; presumably the locality is simply Natal).

Occurrence: Recent only, northern Brazil.

Figured specimens: Fig. 8, SDSNH 62609 (holotype). Fig. 9, MORG 22.616; height 6.5 mm, diameter 3.3 mm; locality, Ilha do Farol, Atol das Rocas [off Rio Grande do Norte], Brazil.



Text-figure 4. *Aspella morchi* Radwin and D'Attilio; MORG 22.616; height 6.5 mm, diameter 3.3 mm; locality, Ilha do Farol, Atol das Rocas, Brazil. Detail of intritacalx (X 60).

Discussion: As noted above, most specimens cited by Rios (1970, p. 83; 1975, p. 87) as *Aspella anceps* are *A. morchi.* Apparently, *A. morchi* has a more extensive range, extending from Pará to Bahia; but *A. cryptica* is reported only from Bahia and the adjoining states of Alagoas and Espírito Santo.

The two Brazilian species are both relatively small, but may be distinguished by the smooth shell of *A. cryptica* in contrast to the somewhat angulate, nodulose shell of *A. morchi.* The intritacalx in both species is very characteristic, with that of *A. morchi* having much larger punctae (compare text-figs. 3 and 4). Houart (1991a, text-figs. 9, 10, 29) and Leal (1991, pl. 18, fig. K) have both figured specimens of *A. morchi,* demonstrating that the protoconch has one and one-half bulbous whorls, as do the majority of species of *Aspella.*

Genus DERMOMUREX Monterosato, 1890

Dermomurex MONTEROSATO, 1890, Natural. Sicil., v. 9, p. 181 (new name for *Poweria* Monterosato, 1884, *non* Bonaparte, 1840).

Type species: *Murex scalarinus* Bivona-Bernardi, 1832 (= *M. scalaroides* Blainville, 1829), by original designation (for *Poweria*).

Discussion: The number of species placed in the genus *Dermomurex* has increased from 32 Recent and fossil species in 1975 to 58, as of this work, in which four additional species are named. Many of these are from the Indo-Pacific area where, in 1975, only four fossil species and two Recent ones were recognized (one had no known name in 1975 but it proved to have been named *Phyllocoma neglecta* Habe and Kosuge, 1971, and now is referred to *Trialatella*). Table 2 shows the numbers of species in the different subgenera of *Dermomurex* and their geographic distribution. These numbers include fossil and living species without distinction, as several species occur both in the Recent fauna and in the fossil record.

Subgenus DERMOMUREX s.s.

Discussion: Previously I noted (Vokes, 1975, p. 129) that, for the most part, Recent species of *Dermomurex* s.s. are confined to the New World. This observation has been modified somewhat by the recognition of two previously described Australian species (*D. angustus* and *D. goldsteini,* see Vokes, 1985b) and the description of a third, also from Western Australia (*D. raywalkeri* Houart, 1986). At this writing there are 12 New World (including three described herein) and four Old World species in the living fauna (three Australian, one Mediterranean).

As in "*Aspella anceps*," many specimens of *Dermomurex* are misidentified. In looking through collections, first in Australia and then in the U.S., I discovered several new species, variously identified by the name of any previously described species. Obviously the group is still poorly known and additional undescribed species doubtlessly hide incognito in other collections.

One Australian fossil species, "*Murex*" *crassiliratus* Tate, 1888, previously attributed to *Dermomurex* s.s. (Vokes, 1971b, p. 37) is referable to *Pygmaepterys*. However, another Australian fossil species, *D. garrardi* Vokes, 1985 [previously misidentified in collections as *Litozamia didymus* (Tate, 1888), or *Pterynotus bifrons* (Tate, 1888)], occurs in beds of Balcombian (middle Miocene) age. This form may well be most closely related to the Indo-Pacific species, *Dermomurex (Trialatella) neglecta* (Habe and Kosuge). It certainly bears little resemblance to the typical group of species such as *D.(D.) matercula* and its descendants.

DERMOMUREX (DERMOMUREX) MATERCULA Vokes
Plate 13, figure 1

Dermomurex (Dermomurex) matercula VOKES, 1975, Tulane Stud. Geol. Paleont., v. 11, no. 3, p. 133, pl. 2, fig. 3.

Holotype: USNM 647442; height 16.2 mm, diameter 8.5 mm.

Type locality: TU 830, Chipola Formation; Tenmile Creek, at power-line crossing about one mile [1.6 km] west of Chipola River (SE 1/4 Sec. 12, T1N, R10W), Calhoun County, Florida.

Occurrence: Chipola Formation, Florida.

Figured specimen: USNM 647442 (holotype).

Additional locality: TU 546.

Discussion: This, the oldest known species of *Dermomurex* s.s., remains as rare as when described. We have collected a few additional specimens but they add little information.

TABLE 2

Distribution of species (fossil and Recent) in the subgenera of *Dermomurex* by geographic region.

Subgenus	Western Atlantic	Eastern Pacific	Europe	Indo-Pacific	Total
Dermomurex s.s.	13	3	4	6	26
Gracilimurex	1	1	–	–	2
Trialatella	6	1	2	2	11
Takia	5	1	2	8	16
Viator	–	–	–	3	3
Total	25	6	8	19	58

DERMOMUREX (DERMOMUREX) GRANULATUS
Vokes
Plate 13, figure 2

Dermomurex (Dermomurex) granulatus VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 60, pl. 7, figs. 4-6.

Holotype: USNM 323889; height 15.4 mm, diameter 7.4 mm.

Type locality: TU 1296, Gurabo Formation; Río Gurabo, both sides, from 1 km above the horse-trail to the base of the formation approximately 2 km above the trail, or about 3 to 4 km (airline) above the ford on Los Quemados-Sabaneta road, Dominican Republic.

Occurrence: Gurabo Formation, Dominican Republic.

Figured specimen: USNM 323889 (holotype). Additional localities: TU 1212, 1215, 1227A, 1250, 1354.

Discussion: When *Dermomurex (Dermomurex) granulatus* was described, I considered it as the intermediate stage between *D. matercula* and *D. pauperculus*. However, in overall morphology it has a greater resemblance to *D. pacei* (which was named while my paper was in press), but differs in having a less elevated spire and a smaller aperture. The line of *D. granulatus/D. pacei* almost certainly is descended from the French Middle Miocene *D. tenellus* Mayer, 1869 (see Vokes, 1975, p. 128, pl. 2, fig. 1), and all three species are characterized by the presence of nodules on the spiral cords.

DERMOMUREX (DERMOMUREX) PACEI
Petuch
Plate 13, figures 6, 7

Dermomurex pacei PETUCH, 1988, Neogene Hist. Trop. Amer. Moll., p. 152, pl. 29, figs. 10, 11.

Holotype: USNM 859939; height 16 mm, diameter 8 mm.

Type locality: Pickles Reef, Plantation Key, Monroe County, Florida.

Occurrence: Moín Formation, Costa Rica. Recent, Bahama Islands and Florida to Cuba.

Figured specimens: Fig. 6, USNM 869508, height 19.1 mm, diameter 9.2 mm; locality, Marianao, La Habana, Cuba (dredged fill). Fig. 7, USNM 462694; height 16.8 mm, diameter 7.7 mm; locality TU 1240. Additional locality: TU 1307.

Discussion: This recently described species is closely related to another recently described eastern Pacific species, *D.(D.) gunteri* Vokes, 1985. When the latter was described (Vokes, 1985a, p. 436, figs. 15, 16), it was observed that "there is no living species with which it may be compared." Astonishingly, only three years later, the Atlantic cognate was discovered.

This species first came to my attention when Hortensia Sarasua of La Habana, Cuba, sent me a collection of muricids from the dredged fill at Marianao. In it were six examples of *D. pacei*, as well as several examples of *D.(D.) sarasuae*, named below.

In the Worsfold Collection at the Academy of Natural Sciences, Philadelphia, there are three specimens (ANSP 374059) of *D. pacei* from Grand Bahama Island. In addition, we have five fossil specimens from the Moín Formation at Puerto Limón, Costa Rica. Further collecting almost certainly will reveal the species living in the southern Caribbean.

DERMOMUREX (DERMOMUREX) CRACENTIS
Vokes
Plate 13, figure 3

Dermomurex (Dermomurex) cracentis VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 61, pl. 7, figs. 7, 8.

Holotype: USNM 323891; height 14.9 mm, diameter 6.9 mm.

Type locality: TU 1219, Gurabo Formation; Río Amina, bluff on east side of river, just above the ford, which is 2 km west of Potrero, and about 3 km downstream from "La Represa," Dominican Republic.

Occurrence: Gurabo Formation, Dominican Republic.

Figured specimen: USNM 323891 (holotype). Additional localities: TU 1227A, 1449.

Discussion: In contrast to the other two species of *Dermomurex* s.s. described from the Dominican Republic, *D.(D.) cracentis* is totally unlike any known New World species. Its nearest relative is the Australian *D. garrardi* Vokes, which is also a slender and relatively smooth species. A modern analog may someday be discovered but at this time we have only this "misplaced" species with no known ancestors or descendants in the New World.

DERMOMUREX (DERMOMUREX) OLSSONI
Vokes
Plate 15, figures 5-7

Aspella scalarioides [sic] (Blainville). MAURY, 1917, Bulls. Amer. Paleontology, v. 5, no. 29, p. 104(268), pl. 17(43), fig. 11 (not of Blainville).

Dermomurex (Dermomurex) engonatus (Dall). VOKES, 1975, Tulane Stud. Geol. Paleont., v. 11, no. 3, p. 136 (in part, Dominican Republic reference only; not of Dall).

Dermomurex (Dermomurex) olssoni VOKES, 1989, Bulls. Amer. Paleontology, v. 98, no. 332, p. 59, pl. 7, figs. 1-3.

Holotype: USNM 323886; height 22.7 mm, diameter 10.2 mm.

Type locality: TU 1215, Gurabo Formation; Río Gurabo, bluffs on both sides, from the ford on the Los Quemados-Sabaneta road upstream to approximately 1 km above the ford, Dominican Republic.

Occurrence: Gurabo Formation, Dominican Republic. Recent, Bahama Islands to Bay Islands, Honduras.

Figured specimens: Fig. 5, USNM 323886 (holotype). Fig. 6, USNM 869511; height 19 mm, diameter 8.1 mm; locality, Alder's Cay, Berry's Island, Bahama Islands. Fig. 7, USNM 323887 (paratype B); height 14.4 mm, diameter 7 mm; locality TU 1215. Additional locality: TU 1354.

Discussion: Previously (Vokes, 1975, p. 136) I included the Dominican Republic specimen that Maury (1917, pl. 17, fig. 11) referred to the Mediterranean *D. scalaroides* (Blainville) in synonymy with *D.(D.) engonatus* (Dall, 1892). With additional Dominican material, it became clear that the Maury specimen was not *D. engonatus* (now synonymized with *D. alabastrum,* see below) but was instead a new species, which I named *D. olssoni.* The latter is shorter, more inflated, and lacks the shoulder spines of *D. alabastrum.*

A question remained, to which living species might the Dominican species be most closely related? It bears only a subgeneric resemblance to the widespread *D. pauperculus,* but no other was closer. Surprisely, a living example of *D. olssoni* was taken recently by Pat Bingham, under a rock at one meter depth, in the Bahama Islands (pl. 15, fig. 6). In the collection of Harry G. Lee, Jacksonville, Florida, there is another large example (height 23.3 mm) taken under rubble at one meter depth, Utila, Bay Islands. These records are shallower than the presumed 20 to 50 meters depth occurrence of the fossil specimens (see Vokes, 1989b, p. 21); perhaps water temperatures are somewhat cooler at these depths today than in the Pliocene and the species has migrated vertically.

PLATE 13

Figures — Page

1. *Dermomurex (Dermomurex) matercula* Vokes (X 3) 60
   USNM 647442 (holotype); height 16.2 mm, diameter 8.5 mm.
   Locality: TU 830, Florida; Chipola Formation.
2. *Dermomurex (Dermomurex) granulatus* Vokes (X 3) 61
   USNM 323889 (holotype); height 15.4 mm, diameter 7.4 mm.
   Locality: TU 1296, Dominican Republic; Gurabo Formation.
3. *Dermomurex (Dermomurex) cracentis* Vokes (X 3) 61
   USNM 323891 (holotype); height 14.9 mm, diameter 6.9 mm.
   Locality: TU 1219, Dominican Republic; Gurabo Formation.

4, 5. *Dermomurex (Dermomurex) worsfoldi* Vokes, n. sp 69
   4. (X 4) ANSP 369631 (holotype); height 12.8 mm, diameter 6 mm.
      Locality: Gold Rock, Grand Bahama Island, Bahama Islands, in 24 meters; Recent.
   5. (X 5) ANSP 391950 (paratype A); height 9.1 mm, diameter 5.1 mm.
      Locality: Tamarind, Grand Bahama Island, Bahamas; Recent.

6, 7. *Dermomurex (Dermomurex) pacei* Petuch (X 3) 61
   6. USNM 869508, height 19.1 mm, diameter 9.2 mm.
      Locality: Marianao, La Habana, Cuba (dredged fill); Recent.
   7. USNM 462694; height 16.8 mm, diameter 7.7 mm.
      Locality: TU 1240, Costa Rica; Moín Formation.

8, 9. *Dermomurex (Dermomurex) pauperculus* (C.B. Adams) (X 2) 65
   8. MCZ 125072, height 30 mm, diameter 14.8 mm.
      Locality: Causeway, Biscayne Bay, Miami, Dade County, Florida; Recent.
   9. Stephens Coll.; height 15.4 mm, diameter 7.3 mm.
      Locality: TU 1000, Florida; Fruitville Formation.

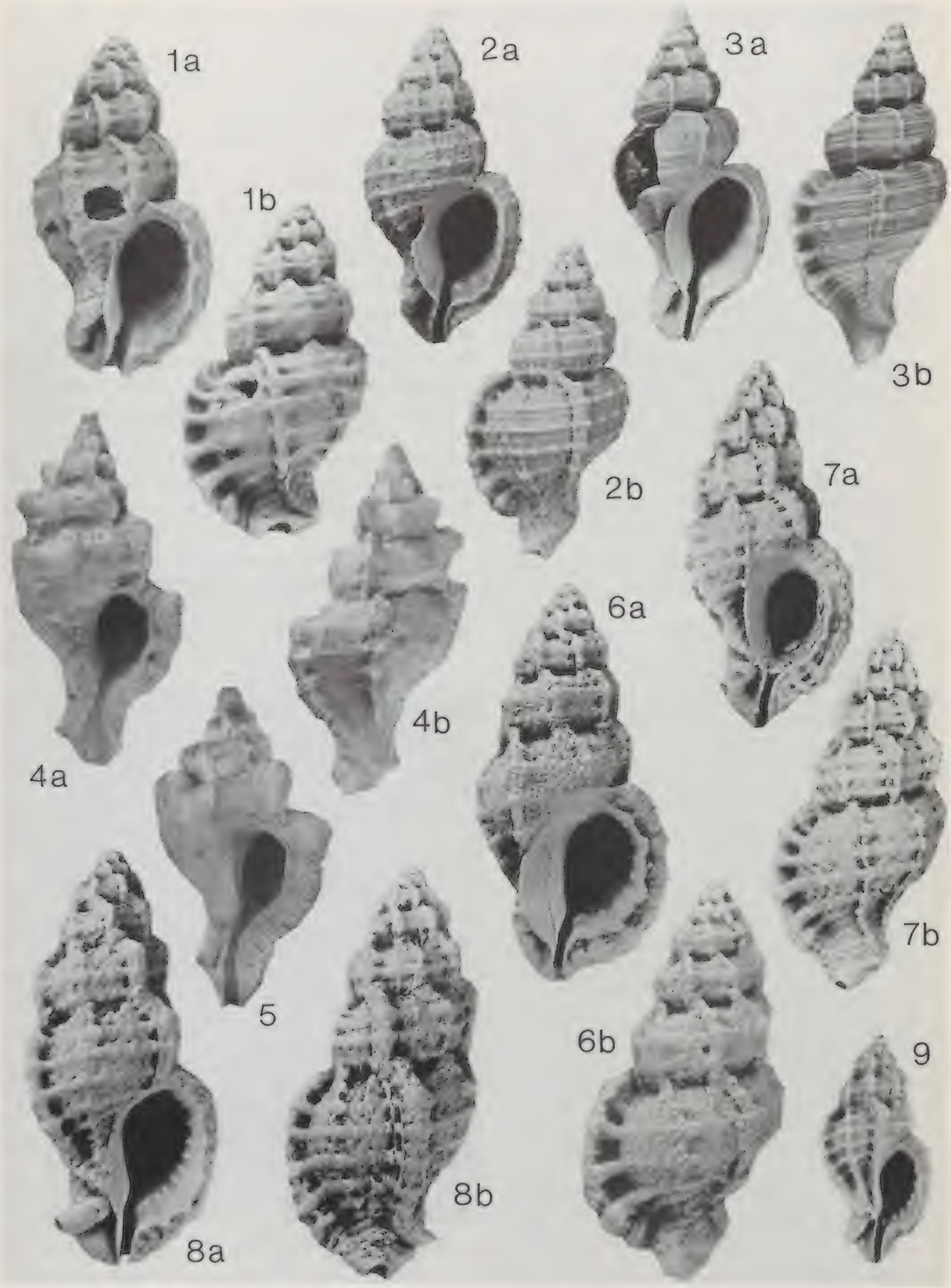


PLATE 13

DERMOMUREX (DERMOMUREX) ALABASTRUM (A. Adams)

Plate 14, figures 1-5; text-figure 5

Murex alabastrum A. ADAMS, 1864, Zool. Soc. London, Proc. for 1863, p. 508; G.B. SOWERBY, JR., 1879, Thes. Conch., v. 4, *Murex*, p. 20, pl. 21, fig. 191; RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 217 ("species of uncertain identity").

Dermomurex alabastrum (A. Adams). VOKES, 1975, Tulane Stud. Geol. Paleont., v. 11, no. 3, p. 138; FAIR, 1976, The Murex Book, p. 19, pl. 16, fig. 216.

Dermomurex (Dermomurex) alabastrum (A. Adams). VOKES, 1976, Tulane Stud. Geol. Paleont., v. 12, no. 1, p. 45, text-fig. 1; VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 212, pl. 1, fig. 14; VOKES, 1985, Veliger, v. 27, no. 4, p. 436, text-fig. 21.

Synonyms:

Murex adamsii KOBELT, 1877, Jahr. Deutsch. Malac. Gesell., v. 4, p. 154 (unnecessary new name for *M. alabastrum* Adams non *M. alabaster* Reeve).

Trophon (Aspella) engonatus DALL, 1892, Wagner Free Inst. Sci., Trans., v. 3, pt. 2, p. 243, pl. 13, fig. 6a.

Aspella (Aspella) engonata (Dall). OLSSON and HARBISON, 1953, Acad. Nat. Sci. Phila., Mon. 8, p. 251, pl. 39, fig. 5.

Aspella pauperculum varians NOWELL-USTICKE, 1969, Suppl. List New Shells St. Croix, p. 15, pl. 3, fig. 692.

Aspella varians Nowell-Usticke. NOWELL-USTICKE, 1971, Suppl. List New Shells (revised edition), p. 12, pl. 6 (no number) (in synonymy with *Aspella cantrainei* Recluz).

Dermomurex (Dermomurex) engonatus (Dall). VOKES, 1975, Tulane Stud. Geol. Paleont., v. 11, no. 3, p. 136, pl. 3, figs. 5, 6.

Dermomurex engonatus (Dall). PETUCH, 1986, Jour. Coastal Resh., v. 2, no. 4, p. 397, pl. 4, fig. 10; PETUCH, 1988, Neogene Hist. Trop. Amer. Moll., pl. 17, figs. 4, 5 (not in text).

Syntypes: BMNH 1974127 [two syntypes: (A) height 25 mm, diameter 11.6 mm; (B) height 20.9 mm, diameter 10.1 mm]; "long. 14 lines, lat. 3 lines" [obviously an error for 6 lines] (= height 29.5 mm, diameter 12.7 mm; Adams, 1864, p. 508).

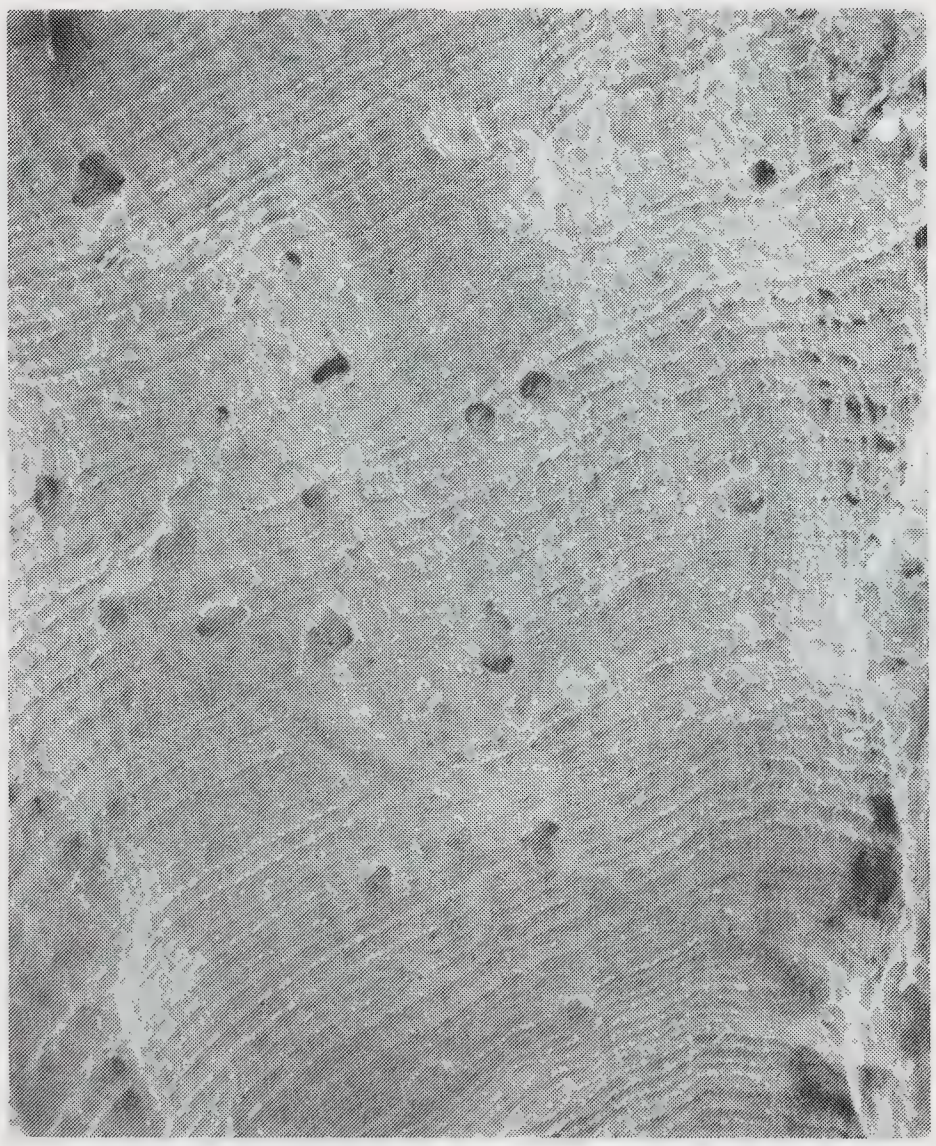
Type locality: Martinique, Lesser Antilles.

Occurrence: Pinecrest, Fruitville (= "Pinecrest Beds"), Caloosahatchee, and Bermont formations, Florida; Waccamaw Formation, South Carolina; Moín Formation, Costa Rica; Tubará Group, Colombia. Recent, St. Croix, U.S. Virgin Islands, to Martinique, Belize, Panama, and Venezuela.

Figured specimens: Fig. 1, USNM 462695; height 25.3 mm, diameter 11.3 mm; locality TU 1512. Fig. 2, USNM 462696; height 15.6 mm, diameter 8.5 mm; locality TU 1512. Fig. 3, AMNH 186115 (paratype, *Aspella varians* Nowell-Usticke); height 29 mm, diameter 13 mm; locality, St. Croix, U.S. Virgin Islands. Fig. 4, Vink Coll.; height 14 mm, diameter 7 mm; locality, Taganga, near Santa Marta, Colombia. Fig. 5, UCMP 39835; height (incomplete) 20.3 mm, diameter 13.6 mm; locality, UCMP S-22, Punta Pua, Dept. of Bolivar, Colombia. Additional localities: TU 558, 1307, 1491.

Discussion: In spite of the fact that *"Murex" alabastrum* was described from Martinique and well-figured by Sowerby (1879, pl. 21, fig. 191), as late as 1975 no one had recognized the species in the western Atlantic. Thus, in February, 1975, I stated (Vokes, 1975, p. 138) that it was another example of the mistaken locality data common among species named by A. Adams, and placed it in synonymy with the eastern Pacific *Dermomurex indentatus* (Carpenter, 1857).

In June of that year, I had the pleasure to visit the late Gordon Nowell-Usticke, at his home in St. Croix, and to study his extensive collection of West Indian



Text-figure 5. *Dermomurex (Dermomurex) alabastrum* (Adams). Vokes Coll., height 14.5 mm, diameter 7.3 mm, locality, Portobelo, Panama, in 30 meters. Detail of intritacalx (X 30).

Muricidae. Imagine my surprise to find that the species he had originally named *Aspella pauperculum varians* (1969) but subsequently (1971) placed into synonymy with *Dermomurex cantainei* (Recluz) was the heretofore unrecognized *Dermomurex alabastrum*.

This information was published (Vokes, 1976a) as an addendum to the *Dermomurex* portion of Cenozoic Muricidae and there I compared the Recent *D. alabastrum* with the Floridian fossil species *D. engonatus*, concluding that the two are probably conspecific. But, at that time I hesitated to place the two in synonymy without more material, particularly of the Recent form. Now, I have examined many additional specimens of *D. alabastrum*, including two syntypes at the British Museum (Natural History), as well as exceptionally well preserved examples of *D. engonatus*, and there are no differences.

In addition to new southern Florida localities, there are examples from the Waccamaw Formation (TU 558) of South Carolina in the collection of Richard E. Petit, North Myrtle Beach, South Carolina. We collected one beautiful specimen in the Moín Formation, Costa Rica (TU 1307), as well as several Recent examples from the dredgings for the harbor at Moín (TU R-369). In the collection of Harry G. Lee, Jacksonville, Florida, there is a single juvenile taken at 6 meters depth, off Alligator Cay, Belize.

As noted previously (Vokes, 1975, p. 137), in the collections of the Museum of Paleontology, Berkeley, there is an incomplete specimen from the Tubará Group at Punta Pua, near Cartegena, Dept. of Bolivar, Colombia, which is figured here (pl. 14, fig. 5). James Ernest has also dredged numerous specimens off Portobelo, Panama, at about 30 meters. These show an intritacalx (text-fig. 5) with a pattern resembling a coarsely woven cloth, similar to that in *D. pauperculus**.

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*Collectors should learn not to attempt to clean the "limy coating" off of specimens of *Aspella* and *Dermomurex*. When examined under a microscope, the pattern of the intritacalx in each species is dramatically different and each is quite beautiful.

DERMOMUREX (DERMOMUREX) PAUPERCULUS (C.B. Adams)

Plate 13, figures 8, 9

Dermomurex (Dermomurex) pauperculus (C.B. Adams). VOKES, 1975, Tulane Stud. Geol. Paleont., v. 11, no. 3, p. 138, pl. 2, figs. 4-7; VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 212, pl. 1, fig. 16; VOKES, 1985, Veliger, v. 27, no. 4, p. 436, text-fig. 19.

Aspella paupercula (C.B. Adams). RIOS, 1975, Brazilian Mar. Moll. Icon., p. 87, pl. 25, fig. 358.

Dermomurex pauperculus (C.B. Adams). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 47, pl. 1, figs. 25, 26; FAIR, 1976, The Murex Book, p. 65, pl. 16, figs. 215, 215a; RIOS, 1985, Seashells of Brazil, p. 87, pl. 31, fig. 384; DE JONG and COOMANS, 1988, Stud. Fauna Curaçao and Caribbean Isl., no. 214, p. 73, pl. 37, fig. 395.

Synonym:

Triton cantrainei RECLUZ, 1853, Jour. de Conchyl., v. 4, p. 246, pl. 8, fig. 10.

Lectotype: MCZ 156124; height 15.9 mm, diameter 7.8 mm (designated by Clench and Turner, 1950, p. 382).

Type locality: Jamaica.

Occurrence: Fruitville Formation (= "Pinecrest Beds"), Florida; unnamed Pleistocene formation, Panama; Moín Formation, Costa Rica. Recent, from Florida to Ceará, Brazil (Rios, 1985, p. 87), east coast of Central America from Mexico to Panama and northern South America.

Figured specimens: Fig. 8, MCZ 125072, height 30 mm, diameter 14.8 mm; locality, Causeway, Biscayne Bay, Miami, Dade County, Florida. Fig. 9, Stephens Coll., height 15.4 mm, diameter 7.3 mm; locality TU 1000.

Discussion: Dermomurex (Dermomurex) pauperculus is the most abundant and widespread species of *Dermomurex* in the western Atlantic. It is common throughout the Florida Keys. We also have specimens from the Bay Islands, Honduras (TU R-503), Costa Rica (TU R-366), Panama (TU R-181; Portobelo, James Ernest) and Venezuela (Los Roques, Work, 1969; Punta Tarma, Dto. Fed., Pierre Hoeblich; Playa Grande, Dto. Fed., J. Gibson Smith). Radwin and D'Attilio (1976, p. 47) have reported it from Trinidad, de Jong and Coomans (1988, p. 73) from Curaçao, and Rios (1975, p. 87; 1985, p. 87) from Ceará, northern Brazil. It occurs in depths ranging from intertidal to as much as 30 meters, usually under stones or dead coral.

Because of the shallow habitat, this species is rare in the fossil record. One specimen (pl. 13, fig. 9) has been collected in the Fruitville Formation at Sarasota, Florida. We have a single juvenile specimen from the Moín Formation, Costa Rica (TU 954), and there is one incomplete example from the Pleistocene at Mt. Hope, Panama (ANSP 184739). These three specimens complete the known occurrence in the fossil record.

In his report on mollusks occurring in the Los Roques Archipelago, Venezuela, Work listed *"Aspella" paupercula,* and figured the egg capsules of individuals raised in captivity (1969, p. 669, text-fig. 4). The capsules are unusual in that they bear little resemblance to typical vase-shaped muricine capsules but are virtually identical to those of the Magellanic *Trophon geversianus* (Pallas, 1774), type of the genus *Trophon*. This almost certainly represents convergence in these only distantly related forms.

Muricid egg capsules, in general, are more reflective of the level of "primitiveness" *vs.* "advancement" than phylogenetic relationships. Presumably, *D. pauperculus* is relatively primitive for a member of the Muricinae and Trophon s.s. (which is the only group of the Trophoninae to have such capsules) is the most advanced of the Trophoninae. Unfortunately we have no information on other species of *Dermomurex,* so one cannot say if this is characteristic of the group as a whole, but in most muricids all of the species of a single subgenus have more or less similar (but by no means identical) egg capsules.

Dermomurex (Dermomurex) binghamae Vokes, n. sp.
Plate 14, figure 8

Description: Shell stout, protoconch and early whorls unknown. At least five teleoconch whorls in adult. Axial ornamentation on early whorls of six broad, low ridges; on about fourth teleoconch whorl alternate ridges strengthening into varices, the other ridges remaining as intervarical swellings, best seen at intersection with spiral cords. Varices low, rounded, each abutting corresponding varix on preceding whorl, but placed somewhat abaperturally, forming a spiral line up the spire. Spiral ornamentation of three low indistinct cords on spire whorls, seven cords on body whorl, most obvious adjacent to varices, where deep pits are formed on both ad- and abapertural sides between the cords. Suture impressed, midway between each pair of varices a flattened buttress formed by intervaricial ridges, leaving deep pits on either side. Aperture rounded, inner lip smooth, appressed; outer lip with five or six nodules on inner side, corresponding to spaces between spiral cords.

PLATE 14

Figures — Page

1-5. *Dermomurex (Dermomurex) alabastrum* (A. Adams) 64
1. (X 2) USNM 462695; height 25.3 mm, diameter 11.3 mm.
Locality: TU 1512, Florida; Caloosahatchee Formation.
2. (X 3) USNM 462696; height 15.6 mm, diameter 8.5 mm.
Locality: TU 1512, Florida; Caloosahatchee Formation.
3. (X 2) AMNH 186115 (paratype, *Aspella varians* Nowell-Usticke); height 29 mm, diameter 13 mm.
Locality: St. Croix, U.S. Virgin Islands; Recent.
4. (X 3) Vink Coll.; height 14 mm, diameter 7 mm.
Locality: Taganga, near Santa Marta, Colombia; Recent.
5. (X 2) UCMP 39835; height (incomplete) 20.3 mm, diameter 13.6 mm.
Locality: UCMP S-22, Punta Pua, Dept. of Bolivar, Colombia; Tubará Group.
6. *Dermomurex (Dermomurex) sarkini* Vokes, n. sp. (X 4) 69
USNM 377396 (holotype); height 12.7 mm, diameter 6.5 mm.
Locality: TU 1240, Costa Rica; Moín Formation.
7. *Dermomurex (Dermomurex) obeliscus* (A. Adams) (X 2 1/2) 68
USNM 838038; height 23.5 mm, diameter 11 mm.
Locality: Islote Island, Nayarit, Mexico; Recent.
8. *Dermomurex (Dermomurex) binghamae* Vokes, n. sp. (X 2 1/2) 66
USNM 860294 (holotype); height 20 mm, diameter 10.8 mm.
Locality: Norman Cay, Bahama Islands; Recent.

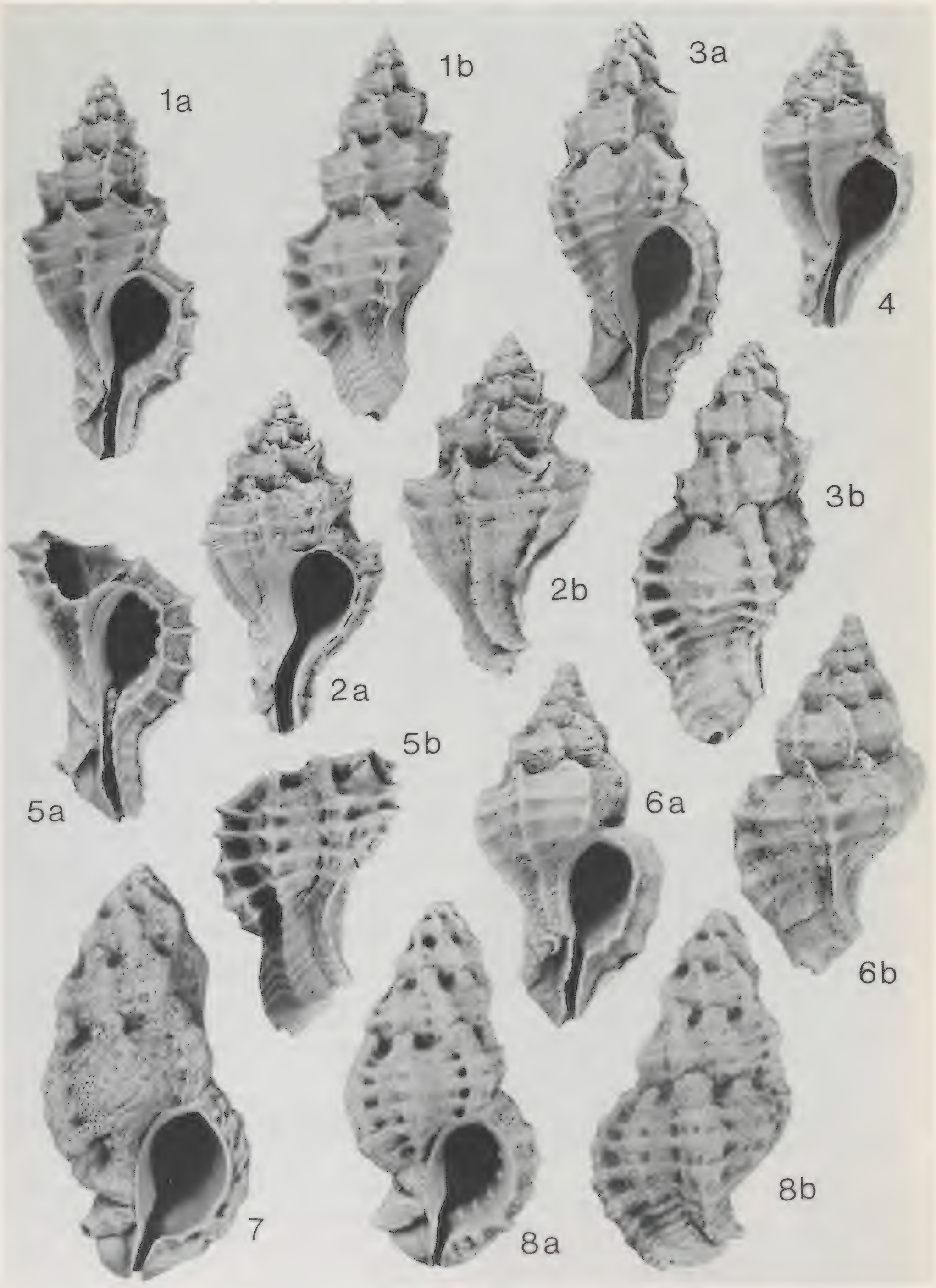


PLATE 14

Siphonal canal short, strongly recurved dorsally. Shell covered with a thick intritacalx, the exact nature of which is unknown (not preserved in holotype specimen). Shell color white with a brown blotch in advance of each varix and strongest at shoulder area.

Holotype: USNM 860294; height 20 mm, diameter 10.8 mm.

Type locality: Norman Cay, Bahama Islands.

Etymology of name: In honor of Patricia Bingham (Mrs. Richard Bingham), West Palm Beach, Florida, who collected the holotype.

Occurrence: Recent only (known only from the type locality).

Figured specimen: USNM 860294 (holotype).

Discussion: Dermomurex binghamae is a short, stout species, with the appearance of being a cross between the Atlantic *D.(D.) pauperculus* and the eastern Pacific *D.(D.) obeliscus* (A. Adams, 1853). From its Atlantic relative, the new species differs in being shorter and having heavier varices, which are better aligned up the spire. From the Pacific *D. obeliscus,* it differs in having the individual whorls more inflated, but with the suture not set as far down onto the succeeding whorl, so that the overall outline of the spire is more evenly tapered (compare with pl. 14, fig. 7). The color of *D. binghamae* is more like that of *D. pauperculus* than of *D. obeliscus,* which is marked by dark brown spiral bands, especially strong where they cross the varices. The intervarical ridges are stronger in *D. binghamae* than in either of the other two species, and combined with the spiral cords give a nodulose appearance to the shell surface.

Unfortunately, the sole example of this new species has had the intritacalx removed but it is assumed to be like that of related species, which is very thick and marked by a linen-like texture (see text-fig. 5).

Dermomurex (Dermomurex) sarasuae
Vokes, n. sp.
Plate 15, figures 8, 9

Description: Shell elongated; protoconch of one and one-half smooth, bulbous whorls; six teleoconch whorls in adult. Axial sculpture of six small flanges on each of the first three teleoconch whorls, then every other one enlarging into a varix, alternate ones remaining as intervarical ridges; three varices and three intervarical ridges per whorl. Varices flattened, with a slight angulation at shoulder, each connected to corresponding varix on preceding whorl, forming a spiral line up the spire. Spiral ornamentation weak, none on earliest whorls, gradually developing into three major cords on spire whorls and five on body whorl. Numerous fine threads both on top of and between spiral cords over entire shell surface. Spiral cords crossing over varices, forming large welts. At intersection of intervarical ridges and spiral cords a line of sharp nodules produced. Suture impressed, except at intervarical ridges, where buttress-like structures attach to preceding whorl. Aperture elongate-oval; inner lip smooth, appressed. Inner side of outer lip with five heavy denticles, corresponding to spaces between spiral cords. Siphonal canal short, recurved dorsally. Shell surface covered by a heavy linen-like intritacalx. With intritacalx present deep pits formed between spiral cords adjacent to varices on both ad- and abapertural sides. These not conspicuous without intritacalx being present.

Holotype: USNM 860295; height 17.5 mm, diameter 7.8 mm

Type locality: Marianao, La Habana, Cuba (dredged fill).

Etymology of name: In honor of Dra. Hortensia Sarasua, of La Habana, Cuba, for her many contributions to Caribbean malacology.

Occurrence: Recent only, Cuba to Honduras.

Figured specimens: Fig. 8, USNM 860295 (holotype). Fig. 9, USNM 860296 (paratype); height 12.3 mm, diameter 5.5 mm; locality, Marianao, La Habana, Cuba (dredged fill).

Discussion: Some time back I was sent a collection of muricids by Dra. Hortensia Sarasua, La Habana, Cuba, from material dredged to make the harbor at Marianao, La Habana. The collection was rich in specimens of *Dermomurex,* including a new species, here named *D. sarasuae* in her honor, together with numerous examples of *D.(D.) pacei* Petuch (see pl. 13. fig. 6).

This new species has some resemblance to *D. pacei* but differs in lacking the enlarged inductura, or expanded inner lip, characteristic of *D. pacei* and its Pacific cognate, *D. gunteri.* The varices of *D. sarasuae* are also more persistent than in the latter species, where in late growth stages they tend to disappear.

There is a stronger similarity to the species from the Gurabo Formation, *D.(D.) olssoni* Vokes, but *D. sarasuae* is a narrower shell with a correspondingly narrower aperture (compare pl. 15, figs. 7 and 9). There are also more numerous denticles on the inner side of the outer lip in *D.*

olssoni, which has about eight, often paired denticles; *D. sarasuae* has only five very heavy denticles.

In addition to these Cuban examples, specimens have also been collected by Kevan Sunderland, diving at night, about 18 meters depth, off Utila, Bay Islands, Honduras, and by Emilio Garcia, under rocks at Roatan, Bay Islands.

Dermomurex (Dermomurex) sarkini
Vokes, n. sp.
Plate 14, figure 6

Description: Protoconch of one and one-half bulbous whorls, six teleoconch whorls in the immature holotype. Axial ornamentation on early teleoconch of six flange-like varices on each whorl, on sixth teleoconch whorl every other varix reduced to become an intervarical swelling, barely visible except where crossing the suture. Three varices (presumably) on each successive whorl. Varices rounded, with a small free-standing flange along abapertural edge, best developed at base of body whorl. Spiral ornamentation beginning with a single cord at periphery, gradually intercalating a smaller cord on either side; on body whorl five spiral cords, three visible on previous whorls. Faint spiral threads between major cords, barely seen and masked by intritacalx in life. Suture impressed, on adult body whorl interrupted by crossing of intervarical swellings. Aperture rounded; inner lip smooth, appressed; outer lip with probably seven nodules on inner side, those on anterior portion better developed. Siphonal canal moderately long, recurved, with a small fasciole. In life shell surface covered by a thick intritacalx, but only remnant patches remaining on the fossil holotype.

Holotype: USNM 377396; height 12.7 mm, diameter 6.5 mm.

Type locality: TU 1240, Moín Formation; Barrio Los Corales, top of hill at end of road that passes Standard Fruit Co. box factory, 1.8 km north of main highway at Pueblo Nuevo, which is 2 km west of Puerto Limón, Costa Rica.

Etymology of name: In honor of the late Edward Sarkin, of Orlando, Florida, longtime student of the Muricidae.

Occurrence: Moín Formation, Costa Rica.

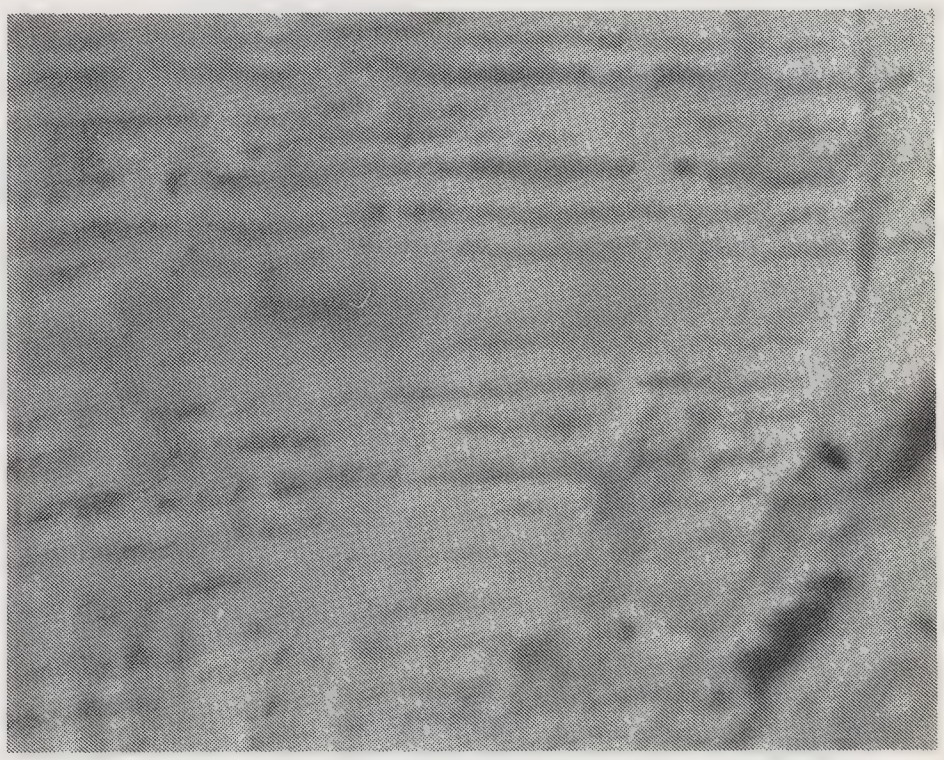
Figured specimen: USNM 377396 (holotype).

Discussion: From the middle Pleistocene beds of the upper Moín Formation (TU 1240, topographically the highest point on the Limón Peninsula; dated as planktic zone N.22 by Dr. W.H. Akers, personal communication), we have a single specimen that is closely related to the European *D.(D.) scalaroides* (Blainville, 1829), type of the genus *Dermomurex* (see Vokes, 1975, pl. 5, fig. 8), but which differs in being smaller, with sharper varices, a lower spire, and a longer siphonal canal.

The morphology of this new species is intermediate between those forms assigned to *Dermomurex* s.s. and those assigned to *Trialatella,* confirming the gradational nature of these two taxa. Radwin and D'Attilio (1976) resolved this difficulty by placing all species in *Dermomurex* s.s., but there is a valid distinction to be made between most of the species. Due to its simliarity to the type of the genus, this species is better placed in *Dermomurex* s.s.

Dermomurex (Dermomurex) worsfoldi
Vokes, n. sp.
Plate 13, figures 4, 5; text-figure 6

Description: Shell elongate, protoconch of one and one-half rounded whorls. Teleoconch of five whorls in largest specimen seen, probably six in fully adult shell. Axial ornamentation on earliest teleoconch whorls of six lamellae. On third teleoconch whorl every other lamella enlarged into a varix, alternate ones remaining as angulate intervarical ridges, three varices and three ridges per whorl. Varices thin, sharp-edged, with an angulation at the shoulder. Spiral ornamentation essentially lacking; adult body whorl with four faint flattened cords, best seen crossing and immediately adjacent to var-



Text-figure 6. *Dermomurex (Dermomurex) worsfoldi* Vokes, n. sp. ANSP 369631 (holotype); height 12.8 mm, diameter 6 mm; locality, Grand Bahama Island, Bahama Islands. Detail of intritacalx (X 25).

ices. Suture simple, between each pair of varices a flattened buttress extending across suture to preceding whorl. Aperture ovate, inner lip smooth, appressed entire length. Outer lip smooth, edge crenulated by spiral cords (margin recessed into each almost invisible cord). Siphonal canal moderately long, wide, recurved at distal end. Surface covered by a heavy white intritacalx, when fresh almost smooth; when slightly worn marked by numerous fine spiral tunnels crossing over entire surface.

Holotype: ANSP 369631; height 12.8 mm, diameter 6 mm.

Type locality: Gold Rock, Grand Bahama Island, Bahama Islands, in 24 meters.

Etymology of name: In honor of Mr. Jack Worsfold, who's collection of Bahamian mollusks is now deposited at the Academy of Natural Sciences, Philadelphia.

Occurrence: Recent only, Bahama Islands (known only from vicinity of type locality).

Figured specimens: Fig. 4, ANSP 369631 (holotype). Fig. 5, ANSP 391950 (paratype A); height 9.1 mm, diameter 5.1 mm; locality, Tamarind, Grand Bahama Island, Bahamas.

Discussion: In the Worsfold collection, now at the Academy of Natural Sciences, Philadelphia, there are three specimens originally identified as *Dermomurex abyssicola,* which are, however, a new species. The species is similar to *D. (Trialatella) abyssicola* and, for this reason, there is a question whether it should be assigned to *Trialatella* or to *Dermomurex* s.s. The lack of strong spiral ornamentation and the flattened wing-like varices are characters nearest to *Trialatella.* But there is no varical extension along the siphonal canal and the general appearance of the shell is most similar to *D. sarasuae,* n. sp., differing in having more alate varices, and a more triangular shape due to the extensions of the varices at the shoulder. As discussed further under the subgenus *Trialatella* (below) the assignment of certain species to either *Dermomurex* s.s. or *Trialatella* is totally subjective. The three species, *D. worsfoldi, D. kaicherae,* and *D. glicksteini,* are intermediate in the spectrum of characters that define these two subgenera.

From *D.(T.) abyssicola,* this new species is distinguished by its narrower form (compare pl. 13, fig. 4 and pl. 17, fig. 4) and by the presence of varical expansions at the shoulder rather than along the siphonal canal, as is typical of *Trialatella.*

The holotype is the largest specimen known, and it is clearly immature. Given the extreme variability of *Dermomurex* species through the range of growth stages, it is not certain exactly what the adult shell would look like. In addition to

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PLATE 15

Figures Page

1, 2. *Dermomurex (Dermomurex) kaicherae* Petuch (X 3) 72
1. USNM 859837 (holotype); height 15.7 mm, diameter 7.9 mm.
Locality: Cabo de la Vela, Guajira Peninsula, Colombia; Recent.
2. USNM 869509; height 15.4 mm, diameter 8.5 mm.
Locality: Tortola, British Virgin Islands; Recent.
3, 4. *Dermomurex (Dermomurex) glicksteini* Petuch 72
3. (X 3) USNM 859836 (holotype); height 16.2 mm, diameter 7.5 mm.
Locality: Palm Beach Island, Palm Beach County, Florida, in 150 meters; Recent.
4. (X 3 1/2) USNM 869510; height 12.8 mm, diameter 5.6 mm.
Locality: Bailey's Bay, Bermuda; Recent.
5-7. *Dermomurex (Dermomurex) olssoni* Vokes 61
5. (X 2 1/2) USNM 323886 (holotype); height 22.7 mm, diameter 10.2 mm.
Locality: TU 1215, Dominican Republic; Gurabo Formation.
6. (X 3) USNM 869511; height 19 mm, diameter 8.1 mm.
Locality: Alder's Cay, Berry's Island, Bahama Islands; Recent.
7. (X 3) USNM 323887 (paratype B); height 14.4 mm, diameter 7 mm.
Locality: TU 1215, Dominican Republic; Gurabo Formation.
8, 9. *Dermomurex (Dermomurex) sarasuae* Vokes, n. sp. (X 3) 68
8. USNM 860295 (holotype); height 17.5 mm, diameter 7.8 mm.
Locality: Marianao, La Habana, Cuba (dredged fill); Recent.
9. USNM 860296 (paratype); height 12.3 mm, diameter 5.5 mm.
Locality: Marianao, La Habana, Cuba (dredged fill); Recent.

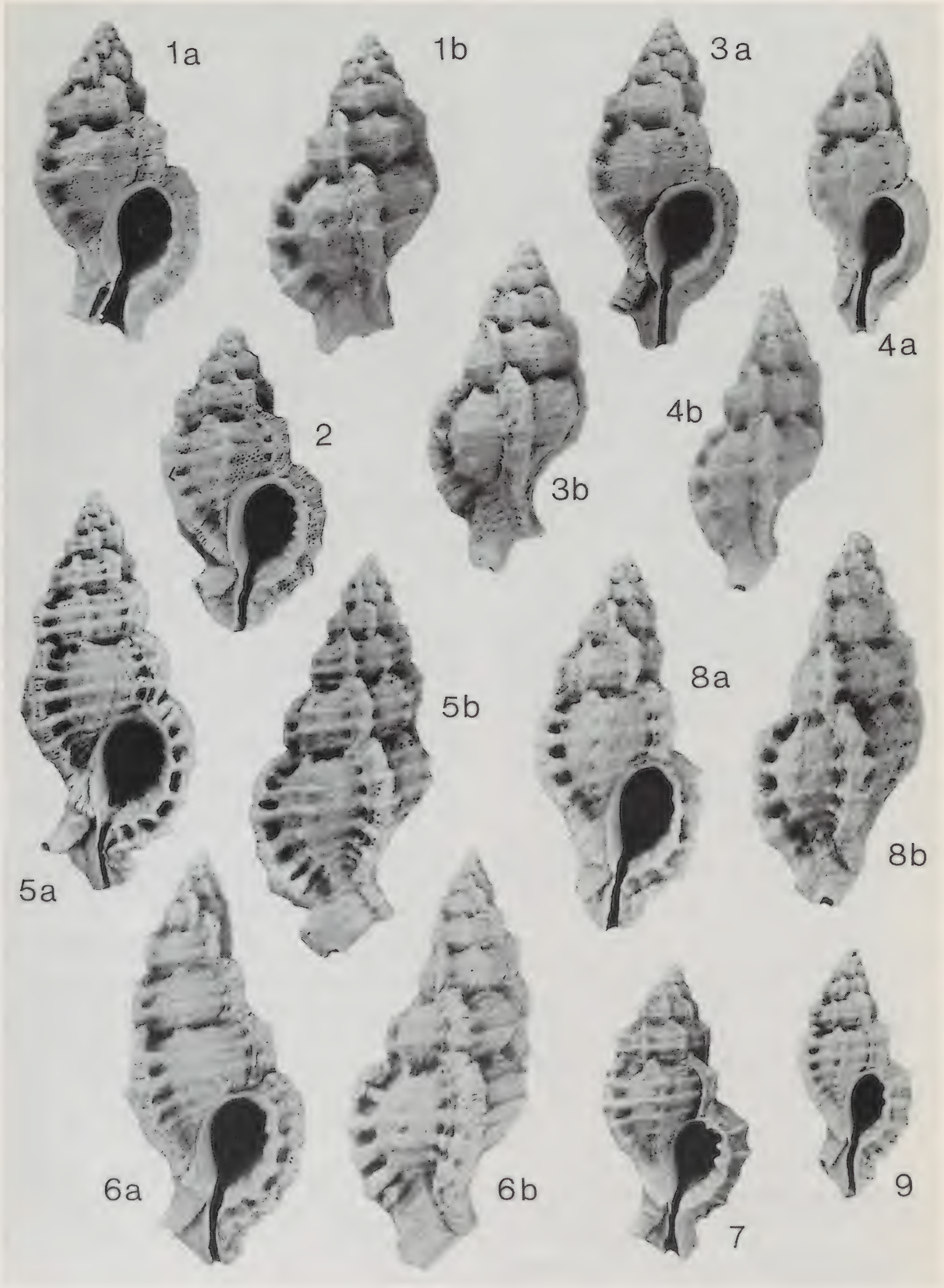

PLATE 15

the holotype, there is a juvenile specimen (height 6.9 mm) from from the type locality (ANSP 391949, paratype B) and there is a third specimen (ANSP 391950, paratype A; pl. 13, fig. 5), from Tamarind, Grand Bahama Island.

DERMOMUREX (DERMOMUREX) KAICHERAE Petuch
Plate 15, figures 1, 2

Dermomurex (Trialatella) kaicherae PETUCH, 1987, New Caribbean Moll. Faunas, p. 96, pl. 24, figs. 17, 18.

Holotype: USNM 859837; height 15.7 mm, diameter 7.9 mm.

Type locality: Cabo de la Vela, Guajira Peninsula, Colombia.

Occurrence: Recent only, from Virgin Islands to Colombia.

Figured specimens: Fig. 1, USNM 859837 (holotype). Fig. 2, USNM 869509; height 15.4 mm, diameter 8.5 mm, locality, Tortola, British Virgin Islands.

Discussion: Although described from off the coast of Colombia, most examples I have seen of this species have been taken in shallow water in the British Virgin Islands. We have also collected examples from St. Croix, U.S. Virgin Islands (TU R-314).

DERMOMUREX (DERMOMUREX) GLICKSTEINI Petuch
Plate 15, figures 3, 4

Dermomurex (Trialatella) glicksteini PETUCH, 1987, New Caribbean Moll. Faunas, p. 25, pl. 3, figs. 15, 16.

Holotype: USNM 859836; height 16.2 mm, diameter 7.5 mm.

Type locality: Palm Beach Island, Palm Beach County, Florida, in 150 meters.

Occurrence: Recent only, Florida to Bermuda.

Figured specimens: Fig. 3, USNM 859836 (holotype). Fig. 4, USNM 869510; height 12.8 mm, diameter 5.6 mm; locality, Bailey's Bay, Bermuda.

Discussion: Dermomurex glicksteini was described from Palm Beach, Florida, but the only examples I have seen are from Bermuda. In addition to the figured example (pl. 15, fig. 4), in the collections of the Academy of Natural Sciences, Philadelphia, there are several beachworn shells from Gibbett's Beach, Bermuda (ANSP 314820).

Subgenus GRACILIMUREX Thiele, 1929

Gracilimurex THIELE, 1929, Handbuch Syst. Weichtierkunde, v. 1, p. 289.

Type species: *Murex bicolor* Thiele, 1929 (*non M. bicolor* Risso, 1826, *etc.*, = *Aspella bakeri* Hertlein and Strong, 1951), by original designation.

Discussion: Adult shells of the two species of *Gracilimurex* (the eastern Pacific *D. bakeri* and the western Atlantic *D. elizabethae*) superficially resemble members of the genus *Aspella,* as discussed previously (Vokes, 1975, p. 129); however, this is the result of convergence, as the radulae are markedly dissimilar and the shell ornamentation is more closely akin to *Dermomurex* s.s. For these reasons the taxon is considered a subgenus of *Dermomurex.*

DERMOMUREX (GRACILIMUREX) ELIZABETHAE (McGinty)
Plate 16, figures 1-5

Dermomurex (Gracilimurex) elizabethae (McGinty). VOKES, 1975, Tulane Stud. Geol. Paleont., v. 11, no. 3, p. 141, pl. 3, figs. 1 (holotype), 2; VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 212, pl. 1, fig. 18 (holotype); VOKES, 1985, Veliger, v. 27, no. 4, p. 437, text-fig. 10 (holotype).

Dermomurex (Gracilimurex) cf. *elizabethae* (McGinty). VOKES, 1975, Tulane Stud. Geol. Paleont., v. 11, no. 3, p. 141, pl. 3, figs. 3, 4.

Dermomurex elizabethae (McGinty). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 45, pl. 1, figs. 15, 16 (holotype); FAIR, 1976, The Murex Book, p. 39, pl. 16, fig. 210 (holotype), 213 (as cf. *elizabethae, ex* Vokes, 1975, pl. 3, fig. 4).

Holotype: ANSP 176449; height 12.5 mm, diameter 5.8 mm.

Type locality: Middle Sambo Shoals, near Key West, Monroe County, Florida.

Occurrence: Bermont Formation, Florida. Recent, Florida to Bahamas and Virgin Islands.

Figured specimens: Fig. 1, ANSP 176449 (holotype). Fig. 2, USNM 869512; height 13.4 mm, diameter 6.5 mm; locality TU R-42. Fig. 3, USNM 739572; height 16.4 mm, diameter 7.8 mm; locality, Pompano Beach, Broward County, Florida (dredged fill). Fig. 4, USNM 869513, height 19.6 mm, diameter 8.7 mm; locality, Pompano Beach, Broward County, Florida, in 3 to 4 meters. Fig. 5, USNM 647443; height 18.5 mm, diameter 8 mm; locality TU 759.

Discussion: When *Dermomurex (Gracilimurex) elizabethae* was previously treated (Vokes, 1975, p. 141) there was a question

of whether the fossil specimens, which occurred only along the Caloosahatchee River (TU 759 and TU 803), were the same species or a form that was intermediate between *D. engonatus* and *D. elizabethae*. Since that time, I have seen many more examples of Recent *D. elizabethae* and the two forms are the same. The holotype of *D. elizabethae* is a relatively small shell, but a growth series from Pompano Beach indicates that this species attains a height of over 20 mm. These larger specimens more closely resemble the fossil examples (compare pl. 16, figs. 4 and 5). In the collection of Harry G. Lee, Jacksonville, Florida, there are two examples taken together at Virgin Gorda, British Virgin Islands, in 3 meters depth, which match the two forms exactly.

In the same discussion, it was questioned whether the fossil specimens were from the "Glades" fauna, now the Bermont Formation, or the underlying Caloosahatchee Formation. At that time there was but a single specimen attributable to *D. engonatus* known from the post-Caloosahatchee beds of Florida, and I speculated about whether *D. elizabethae* had replaced the older species. As stated above, "*D. engonatus*" is alive and well in the area to the south of Florida living under the name of *D. alabastrum,* and the species has simply shifted geographically to warmer waters due to climatic cooling after the Caloosahatchee Formation.

The presence of the closely related species *D.(G.) bakeri* (Hertlein and Strong) (pl. 16, fig. 6) in the eastern Pacific leads to the suggestion that the two cognate forms have a common ancestor, not yet discovered, somewhere in the Miocene and the resemblance to *D. engonatus/alabastrum* is only generic.

Subgenus TRIALATELLA Berry, 1964

Trialatella BERRY, 1964, Leaflets in Malac., v. 1, no. 24, p. 149.

Type species: *Trialatella cunninghamae* Berry, 1964, by original designation.

Discussion: In the last few years a number of new species have been referred to the subgenus *Trialatella*. Some are typical members of the group with alate varices (*D. oxum, D. cuna [= D. antecessor], D. leali*) but some are not greatly different from *Dermomurex (Dermomurex) alabastrum (D. kaicherae, D. glicksteini).*

The actual differences between *Trialatella* and *Dermomurex* s.s. are difficult to list but, in general, in *Trialatella* the spire is shorter and the siphonal canal is more elongated. There is an extension of the varices along the base of the body whorl and siphonal canal, which may be even further expanded by the intritacalx. The early whorls tend to retain the juvenile six varices per whorl longer in the growth cycle than do members of *Dermomurex* s.s.

This is a relatively consistent morphotype that may be recognized as "typical" *Trialatella*. Although *D. glicksteini* and *D. kaicherae* have somewhat more elongated siphonal canals than the typical *Dermomurex* s.s. form, they are more closely related to it than to *Trialatella* and are, therefore, treated as members of the group.

DERMOMUREX (TRIALATELLA) FARLEYENSIS Vokes
Plate 16, figure 7

Dermomurex (Trialatella) farleyensis VOKES, 1975, Tulane Stud. Geol. Paleont., v. 11, no. 3, p. 144, pl. 4, fig. 1.

Holotype: USNM 647448; height 14.5 mm, diameter 7.5 mm.

Type locality: TU 999, Chipola Formation; Farley Creek, about 300 yards (275 meters) downstream from bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W), Calhoun County, Florida.

Occurrence: Chipola Formation, Florida.

Figured specimen: USNM 647448 (holotype).

Additional locality: TU 1196.

Discussion: The oldest known species of *Trialatella* is *D.(T.) farleyensis,* known almost exclusively from the exposures of the Chipola Formation along Farley Creek, Calhoun County, Florida. No additional information can be added.

DERMOMUREX (TRIALATELLA) PTERYNOIDES Vokes
Plate 16, figure 8

Dermomurex (Trialatella) pterynoides VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 61, pl. 7, figs. 9-11.

Holotype: PRI 30013; height 20 mm, diameter 9.6 mm.

Type locality: Zone I (? = TU 1282), Cercado Formation; Río Cana, "Orchid Gorge," above

the bridge at Caimito, Dominican Republic.

Occurrence: Cercado and Gurabo formations, Dominican Republic.

Figured specimen: PRI 30013 (holotype). Additional localities: TU 1227A, 1250.

Discussion: In the material at the Paleontological Research Institution, Ithaca, New York, collected by the Maury 1916 Expedition to the Dominican Republic, there is a beautiful specimen of *Trialatella,* which Maury did not include in her study of the fauna (Maury, 1917). In our collections made in the Dominican Republic there are several additional specimens but none as well preserved as Maury's, which is the holotype of the species.

The Mio/Pliocene Dominican *D.(T.) pterynoides* is similar to the Pleistocene *D.(T.) antecessor* but differs in that the varices are perfectly aligned up the spire, causing it to have a superficial resemblance to members of the genus *Pterynotus;* hence the name.

DERMOMUREX (TRIALATELLA) ANTECESSOR
Vokes
Plate 17, figures 1, 2

Dermomurex (Trialatella) antecessor VOKES, 1975, Tulane Stud. Geol. Paleont., v. 11, no. 3, p. 145, pl. 4, figs. 5, 6.

Synonym:

Dermomurex (Trialatella) cuna PETUCH, 1990, Nautilus, v. 104, no. 2, p. 60, text-figs. 9, 10.

Holotype: USNM 647446; height 17 mm, diameter 8.2 mm.

Type locality: TU 954, Moín Formation; hillcut immediately behind Standard Fruit Company box factory, just west of cemetery at Pueblo Nuevo, about 2 km west of Puerto Limón, Costa Rica.

Occurrence: Moín Formation, Costa Rica; Bermont Formation, Florida. Recent, Panama.

Figured specimens: Fig. 1, USNM 647446 (holotype). Fig. 2, USNM 860527 (holotype, *Dermomurex cuna)*; height 14.3 mm, diameter 7.1 mm; locality, Portobelo, Panama, in 65 meters. Additional localities: TU 1239, 1240.

Discussion: Petuch recently (1990, p. 60, text-figs. 9, 10) described a new species of *Trialatella* from off Portobelo, Panama. In comparing it to the "possible Pleistocene ancestor" *D.(T.) antecessor,* he noted that the latter differed in "being a more elongated species with less developed varices and coarser corded body whorl sculpture" (*ibid.,* p. 62). He neglected to take into account the very different appearance of *Trialatella* species when the intritacalx is present and when it is removed. If the holotype of *D. cuna* were "cleaned" it would look just like *D. antecessor.*

In the description of *D.(T.) cuna,* Petuch considered the small specimen from off Panama that I originally figured as *D.(T.)*

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Figures Page

1-5. *Dermomurex (Gracilimurex) elizabethae* (McGinty) 72
1. (X 4) ANSP 176449 (holotype); height 12.5 mm, diameter 5.8 mm.
Locality: Middle Sambo Shoals, near Key West, Monroe County, Florida; Recent.
2. (X 4) USNM 869512; height 13.4 mm, diameter 6.5 mm.
Locality: TU R-42, Florida; Recent.
3. (X 3) USNM 739572; height 16.4 mm, diameter 7.8 mm.
Locality: Pompano Beach, Broward County, Florida (dredged fill); Recent.
4. (X 3) USNM 869513, height 19.6 mm, diameter 8.7 mm.
Locality: Pompano Beach, Broward County, Florida, in 3 to 4 meters; Recent.
5. (X 3) USNM 647443; height 18.5 mm, diameter 8 mm.
Locality: TU 759, Florida; Bermont Formation.
6. *Dermomurex (Gracilimurex) bakeri* (Hertlein and Strong) (X 3) 73
USNM 869514; height 17.5 mm, diameter 8.5 mm.
Locality: Manzanillo, Colima, Mexico; Recent.
7. *Dermomurex (Trialatella) farleyensis* Vokes (X 3) 73
USNM 647448 (holotype); height 14.5 mm, diameter 7.5 mm.
Locality: TU 999, Florida; Chipola Formation.
8. *Dermomurex (Trialatella) pterynoides* Vokes (X 3) 73
PRI 30013 (holotype); height 20 mm, diameter 9.6 mm.
Locality: Zone I (? = TU 1282), Dominican Republic; Cercado Formation.

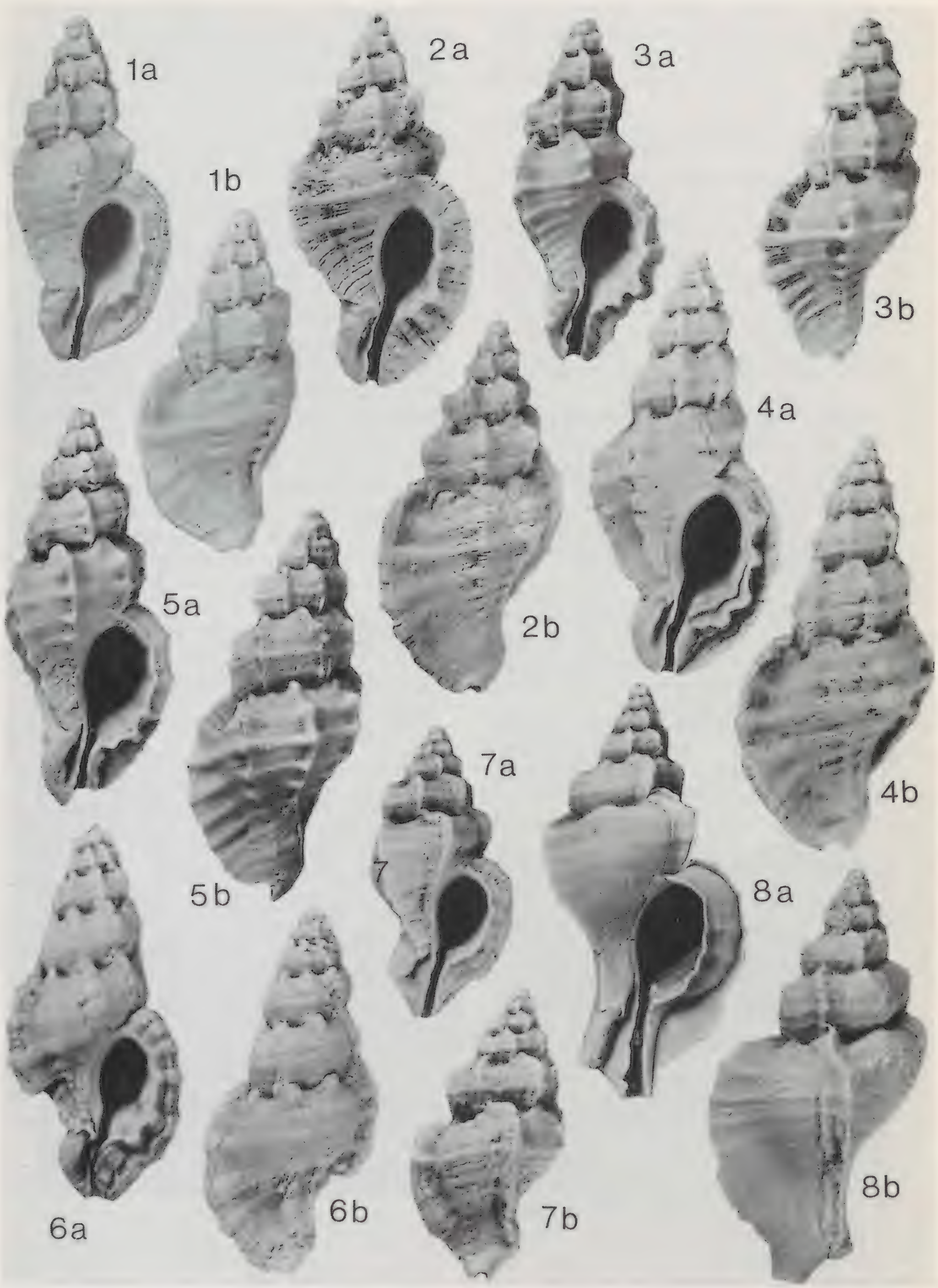


PLATE 16

abyssicola (Vokes, 1975, pl. 4, fig. 3 – subsequently changed to *D. oxum*) also to be referable to *D. cuna*. Geography not withstanding, I still place it with *D. oxum*, as discussed below.

The "unnamed post-Caloosahatchee formation" of Florida, in which this species is represented by a single specimen from locality TU 201 (paratype, Vokes, 1975, pl. 4, fig. 5), is now known as the Bermont Formation. However, I know of no additional Florida specimens, although we have collected several more examples from the Moín Formation.

Dermomurex (Trialatella) abyssicola (Crosse)

Plate 17, figures 3-5; text-figures 7, 8

Dermomurex (Trialatella) abyssicola (Crosse). VOKES, 1975, Tulane Stud. Geol. Paleont., v. 11, no. 3, p. 148 (in part), pl. 4, fig. 2; not pl. 4, fig. 3 (= *D. oxum*); VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 212, pl. 1, fig. 20; VOKES, 1985, Veliger, v. 27, no. 4, p. 437, text-fig. 14.

Dermomurex abyssicola (Crosse). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 44, text-fig. 22 (after Crosse, 1865, pl. 1, fig. 4); LEAL, 1991, Mar. Prosobranch Gast. Oceanic Islands Brazil, p. 141 (in part, not references to *D. oxum*).

Trialatella abyssicola (Crosse). FAIR, 1976, The Murex Book, p. 17, unnumbered text-fig. (after Crosse, 1865, pl. 1, fig. 4); not pl. 16, figs. 214, 214a (= *D. oxum*).

Holotype: Not found; height 11 mm, diameter 6 mm (*fide* Crosse, 1865, p. 30).

Type locality: Guadeloupe, Lesser Antilles.

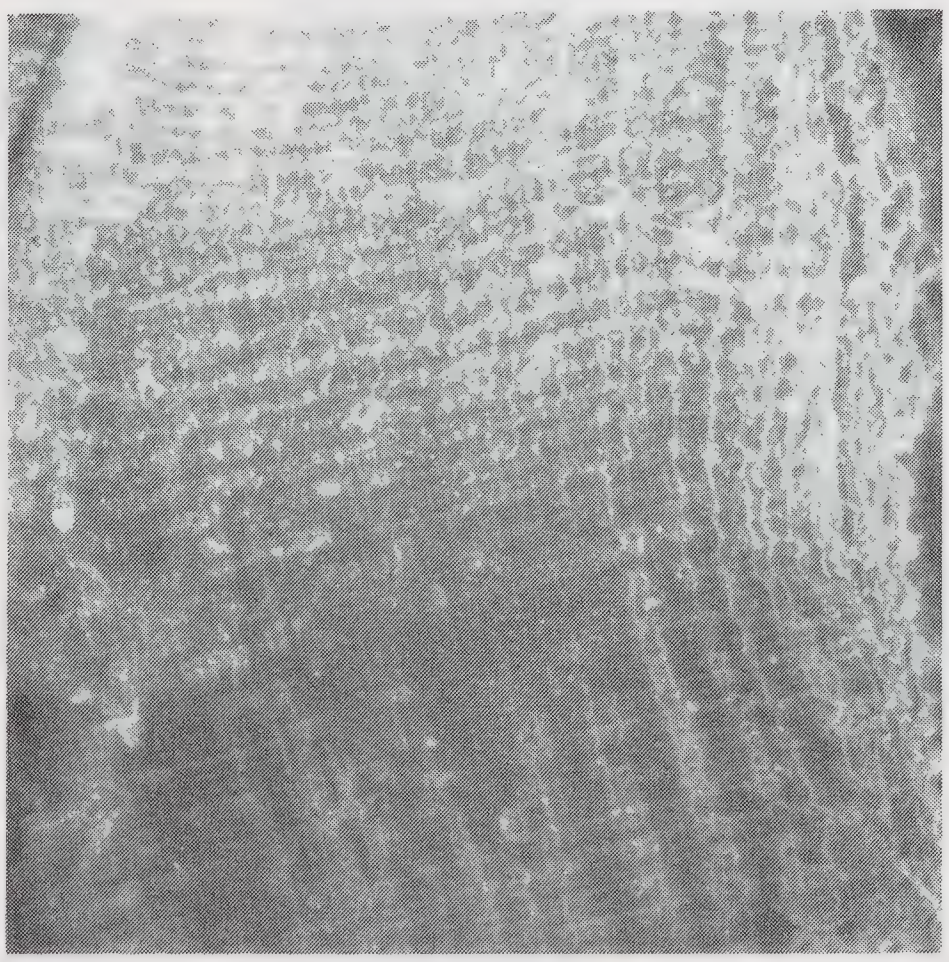
Occurrence: Recent only, from Bahama Islands and Gulf of Mexico to Lesser Antilles.

Figured specimens: Fig. 3, Holotype (after Crosse, 1865, pl. 1, fig. 4). Fig. 4, ANSP 368988; height 14 mm, diameter 7.2 mm; locality, Tamarind, Grand Bahama Island, Bahamas, in 46 to 54 meters. Fig. 5, MNHN; height 7.7 mm, diameter 4.2 mm; locality, Guadeloupe, Lesser Antilles, in 4 meters.

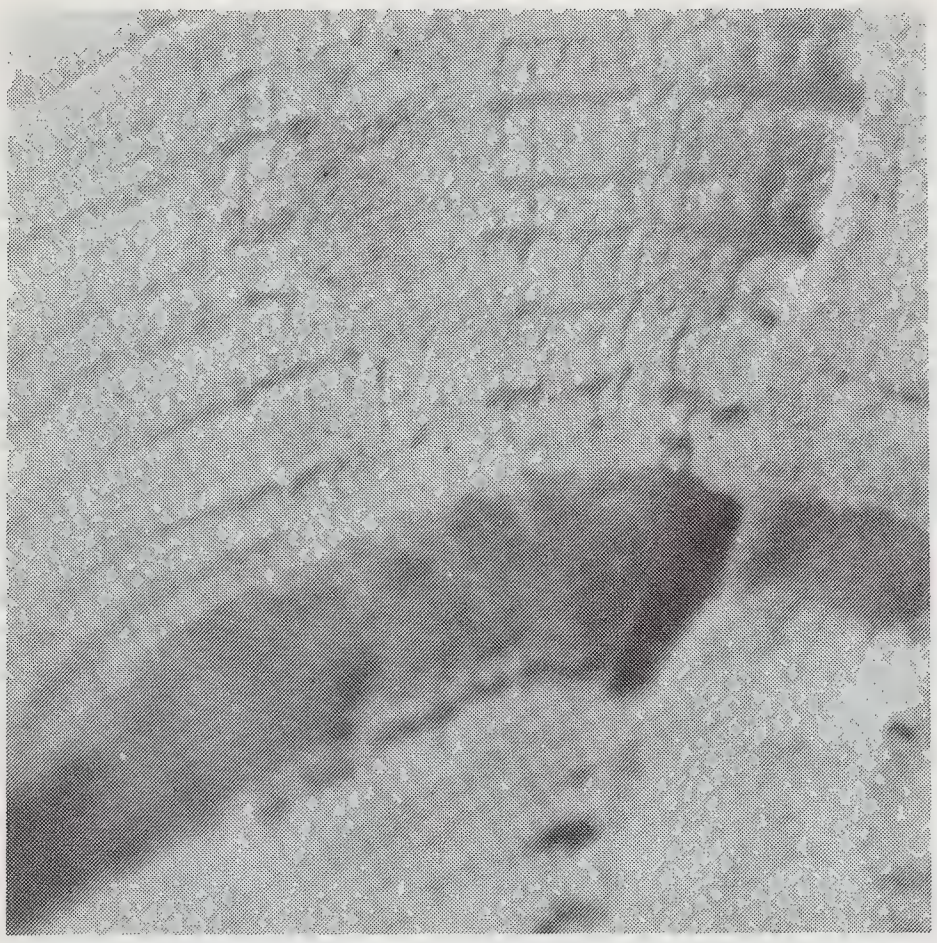
Discussion: Although described over 100 years ago, this species has eluded workers with great success. In the Worsfold collection at the Academy of Natural Sciences, Philadelphia, there is one unquestionable example of this rare form. The holotype was described from 250 fathoms (456 meters) but it is unlikely that the species lives this deep. The Worsfold specimen is from about 50 meters, which is a more probable depth.

By comparing the illustrations of the holotype and the Bahamian example (pl. 17, figs. 3, 4) one can see that the two are identical, including the strange "stripe" encircling the base of the body whorl, which is an area where the intritacalx decorticates. The intritacalx on this species is very distinctive. When unworn, it is marked by a latticework of axial and spiral lines with small punctae developed at the intersections. This is in marked contrast to the intritacalx of *D.(T.) oxum*, which when unworn has a "gritty" appearance, as though small sand grains were embedded in it (compare text-figs. 7 and 9). When worn, both species develop the ornamentation seen in the illustration of the holotype of *D. abyssicola*, with a combination of strong spiral grooves and short axial lines (see text-fig. 8; pl. 17, fig. 8).

I figured a small specimen from off Cape San Blas, Panama (Vokes, 1975, pl. 4, fig. 3) as *D.(T.) abyssicola*, but later changed it to *D.(T.) oxum* Petuch (Vokes, 1985a, p. 437, text-fig. 13). In the description of another western Atlantic species of *Trialatella*, Petuch (1990, p. 60) stated his belief that "this now well known specimen" is, in fact, an example of his *D. cuna*. Comparison of the shell with the holotypes of both *D. cuna* [i.e., *D. antecessor*] and *D.*



Text-figure 7. *Dermomurex (Trialatella) abyssicola* (Crosse); MNHN; height 6.4 mm, diameter 3.3 mm; locality, Guadeloupe, Lesser Antilles, in 4 meters. Detail of intritacalx (X 60).



Text-figure 8. *Dermomurex (Trialatella) abyssicola* (Crosse); ANSP 368988; height 14 mm, diameter 7.2 mm; locality, Tamarind, Grand Bahama Island, Bahamas. Detail of intritacalx (X 25).

oxum (pl. 17, figs. 2, 6, 7) shows that the small Panama shell has the lower spire and heavier spiral cords of *D. oxum*.

At the Muséum National d'Histoire Naturelle, Paris, there are numerous specimens collected by J.P. Pointier from the island of Guadeloupe, the type locality of *D.(T.) abyssicola*. One of the juvenile Guadeloupe specimens, also with an intact intritacalx, is figured here (pl. 17, fig. 5) for comparison with the juvenile *D. oxum*. In addition to the differences in the intritacalx, the decrease in number of varices is delayed so that the shell retains six varices until about the fifth teleoconch whorl in *D. abyssicola* (compare pl. 17, figs. 5 and 7). *Dermomurex abyssicola* apparently lacks the wide varical expansions of *D. oxum*. This also is apparent in the larger specimens (pl. 17, figs. 4, 6). Evidently, *D. abyssicola* does not develop the "typical" *Trialatella* flange along the siphonal canal. Nevertheless, with its resemblance to *D. oxum*, it should be included in this subgenus.

In addition to these figured examples, in my collection there is one specimen said to be dredged off Cedar Key, Florida, at 45 meters depth, by Jim Moore of Bradenton, Florida. If this locality is correct, the range of this species is almost as widespread as *D.(D.) pauperculus*. Its deeper habitat explains why it is less well represented in collections.

Dermomurex (Trialatella) oxum Petuch

Plate 17, figures 6-8; text-figure 9

Dermomurex (Trialatella) abyssicola (Crosse). VOKES, 1975, Tulane Stud. Geol. Paleont., v. 11, no. 3, p. 148 (in part), pl. 4, fig. 3 only (not of Crosse).

Trialatella abyssicola (Crosse). FAIR, 1976, The Murex Book, p. 17 (in part), pl. 16, figs. 214, 214a only (after Vokes pl. 4, fig. 3).

Dermomurex (Trialatella) oxum PETUCH, 1979, Biol. Soc. Washington, Proc., v. 92, no. 3, p. 517, text-figs. 1E, 1F; VOKES, 1985, Veliger, v. 27, no. 4, p. 432, text-figs. 12 (holotype), 13; PETUCH, 1987, New Caribbean Moll. Faunas, pl. 27, figs. 10, 11 (holotype); PETUCH, 1988, Neogene Hist. Trop. Amer. Moll., p. 163, pl. 39, figs. 18, 19 (holotype); HOUART, 1991, Nautilus, v. 105, no. 1, p. 27, text-figs. 1 (intritacalx), 26 (shell).

Dermomurex abyssicola (Crosse). LEAL, 1991, Mar. Prosobranch Gast. Oceanic Islands Brazil, p. 141 (in part).

Holotype: USNM 780648; height 12.5 mm, diameter 6.6 mm.

Type locality: Santa Barbara Island, Abrolhos Archipelago, Bahia, Brazil, in 25 meters.

Occurrence: Recent only, Panama to Brazil.

Figured specimens: Fig. 6, USNM 780648 (holotype). Fig. 7, USNM 739671; height 9 mm, diameter 4 mm; locality TU R-98. Fig. 8, MNHN; height 15.5 mm, diameter 8 mm; locality, Vitória

Text-figure 9. *Dermomurex (Trialatella) oxum* Petuch. USNM 739671; height 9 mm, diameter 4 mm; locality TU R-98. Detail of intritacalx (X 25).

Bank, Espírito Santo, Brazil, in 52 meters (photograph courtesy of R. Houart).

Discussion: Originally, Petuch did not compare *D. oxum* to *D. abyssicola,* stating only that it was the only Atlantic species of Dermomurex resembling the new species. Although the two forms are extremely similar there are certain differences in the overall shape and, especially, in the nature of the intritacalx, as discussed above. Furthermore, according to J.P. Pointier, of the Muséum National d'Histoire Naturelle, Paris, who has collected numerous examples of *D. abyssicola* in Guadeloupe, the latter is never associated with coral-reefs (as is *D. oxum*) but is found on the under side of rocky ledges in about 5 meters depth (personal communication).

Leal (1991, p. 142) considers *D. oxum* and *D. abyssicola* to be the same species, adding that neither Petuch (1979) nor Vokes (1985a) had actually compared *D. oxum* with material from Guadeloupe. The fact that in 1985, I figured both *D. oxum* (1985a, figs. 12, 13) and a specimen from Guadeloupe, which I identified as *D. abyssicola* (1985a, fig. 14), should indicate that I had compared them and considered them to be distinct species, although I did not discuss the comparison.

Dermomurex (Trialatella) leali Houart
Plate 17, figure 9

Dermomurex sp. 1, LEAL, 1991, Mar. Prosobranch Gast. Oceanic Islands Brazil, p. 142.

Dermomurex (Trialatella) leali HOUART, 1991, Nautilus, v. 105, no. 1, p. 27, text-figs. 2 (intritacalx), 5 (protoconch), 27, 28 (both holotype).

Holotype: MORG 26.457; height 9.5 mm, diameter 5.6 mm.

Type locality: *Marion-Dufresne* Station DC 22, Vitória Bank, Espírito Santo, Brazil, in 52 meters.

Occurrence: Recent only (known only from type locality).

Figured specimen: MORG 26.457 (holotype; photograph courtesy of R. Houart).

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Figures

Page
1, 2. *Dermomurex (Trialatella) antecessor* Vokes (X 4) 74
1. USNM 647446 (holotype); height 17 mm, diameter 8.2 mm.
Locality: TU 954, Costa Rica; Moín Formation.
2. USNM 860527 (holotype, *Dermomurex cuna* Petuch); height 14.3 mm, diameter 7.1 mm.
Locality: Portobelo, Panama, in 65 meters; Recent.
3-5. *Dermomurex (Trialatella) abyssicola* (Crosse) 76
3. (X 4) Holotype; height 11 mm, diameter 6 mm (after Crosse, 1865, pl. 1, fig. 4).
Locality: Guadeloupe, Lesser Antilles; Recent.
4. (X 4) ANSP 368988; height 14 mm, diameter 7.2 mm.
Locality: Tamarind, Grand Bahama Island, Bahamas, in 46 to 54 meters.
5. (X 5) MNHN; height 7.7 mm, diameter 4.2 mm.
Locality: Guadeloupe, Lesser Antilles, in 4 meters; Recent.
6-8. *Dermomurex (Trialatella) oxum* Petuch (X 4) 77
6. USNM 780648 (holotype); height 12.5 mm, diameter 6.6 mm.
Locality: Santa Barbara Island, Abrolhos Archipelago, Bahia, Brazil, in 25 meters; Recent.
7. USNM 739671; height 9 mm, diameter 4 mm.
Locality: TU R-98, Panama; Recent.
8. MNHN; height 15.5 mm, diameter 8 mm.
Locality: Vitória Bank, Espírito Santo, Brazil, in 52 meters; Recent.
(Photograph courtesy of R. Houart)
9. *Dermomurex (Trialatella) leali* Houart (X 4) 78
MORG 26.457 (holotype); height 9.5 mm, diameter 5.6 mm.
Locality: *Marion-Dufresne* Station DC 22, Vitória Bank, Espírito Santo, Brazil, in 52 meters; Recent.
(Photograph courtesy of R. Houart)

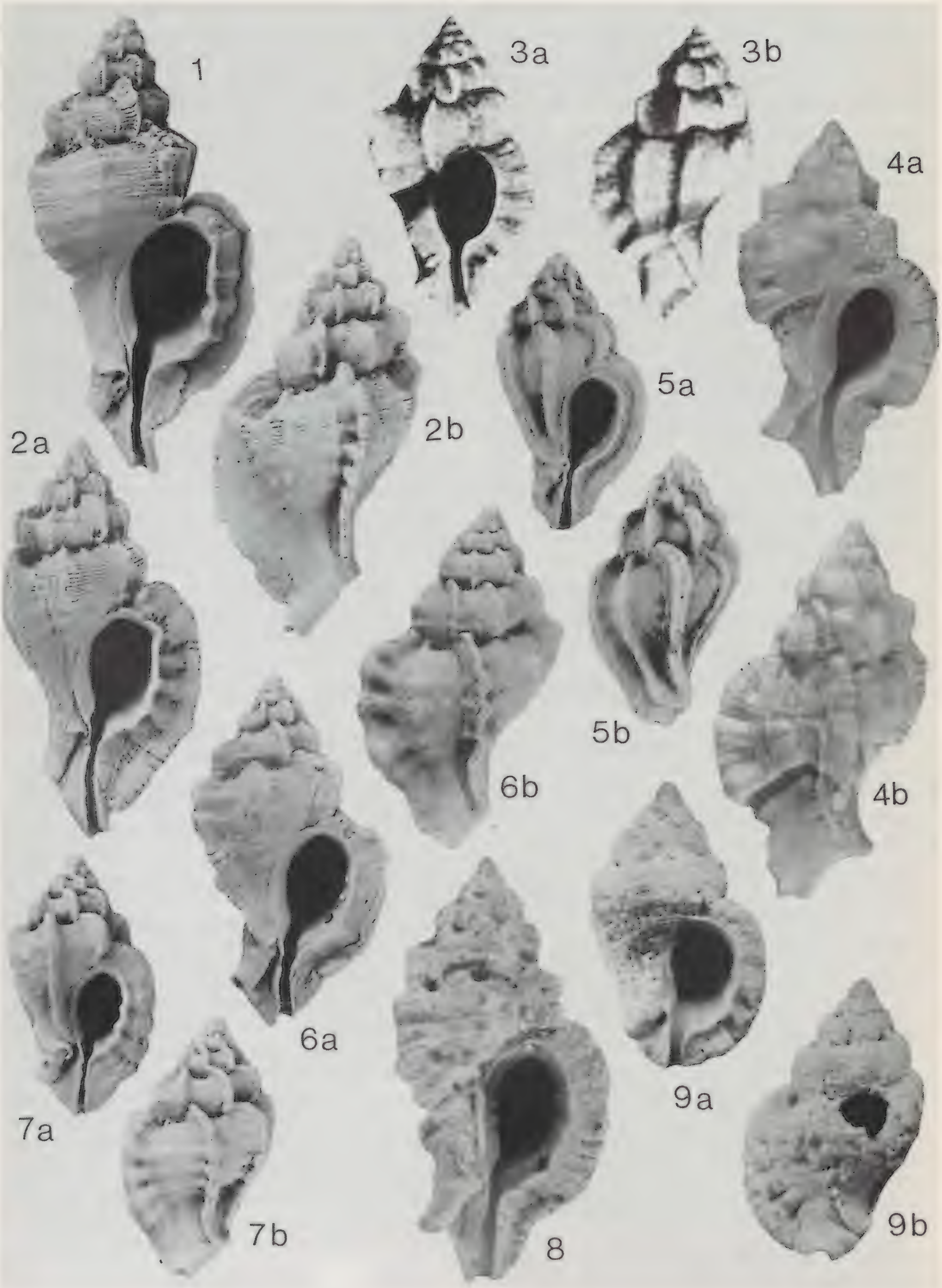

PLATE 17

Discussion: In his description of *D.(T.) leali*, Houart (1991a, p. 31) separated his new species from the other Brazilian species of *Trialatella*, *D.(T.) oxum* by the fact that his shell has five varices on the last whorl, in contrast to three in *D. oxum*. However, it is obvious that his specimen is a juvenile, and an adult would have three varices.

The distinguishing characteristics include the intritacalx, which is much coarser in *D. leali*, the more inflated body whorl, and the shorter siphonal canal. This is a valid new species but it would be misleading to describe it as having five varices; the adult, when found, will have three varices. Houart's type specimen is at the same stage of development as the "now well-known" example of *D. oxum* mentioned above (compare pl. 17, figs. 7 and 9) and one can see that it is just at the point of changing from six varices per whorl to three varices per whorl.

Subgenus TAKIA Kuroda, 1953

Takia KURODA, 1953, Venus, v. 17, p. 190.

Type species: *Murex inermis* Sowerby, 1841 (*non M. inermis* Philippi, 1836, *etc.* = *Dermomurex infrons* Vokes, 1974), by original designation.

Discussion: When the American members of the group of *Dermomurex* species that retain six varices throughout their development were originally studied (Vokes, 1975), several were assigned to *Viator*, a subgenus distinguished by a long *straight* siphonal canal, in contrast to species with a long *recurved* siphonal canal, which are assigned to the subgenus *Takia*.

This decision was based upon the premise that these Oligocene-Early Miocene species were somehow ancestral to the line of the Australian Recent *Dermomurex (Viator) antonius* Vokes, 1974, type of that subgenus. At the time, it was noted that the "Australian Middle Miocene (Balcombian) *D.(V.) asteriscus* (Tate) clearly shows the transition from the relatively short-canaled *D. sexangulus* to the very long-canaled Recent *D. antonius*" (Vokes, 1975, p. 153).

This was changed by the discovery of an Australian species that is not only contemporary with, but remarkably similar in appearance to, the American Late Oligocene *D. sexangulus* (Dall). This Australian "copy" of the American species was named *D.(T.) imitator* Vokes (1985b, p. 53, pl. 2, fig. 7). As both *D. sexangulus* and *D. imitator* have the relatively short, slightly recurved canal and the large inductura (expanded inner lip) of typical *Takia*, in contrast to the long straight canal and small inductura of *Viator*, it was decided to place both of these Oligocene species, as well as the American descendants of the line back into *Takia*, and let the Australian line evolve in place, though a series of species discussed at the same time (Vokes, 1985b, pp. 52-57).

Thus, as presently construed, the evolution of *Viator* would begin with the Late Oligocene *Dermomurex (Takia) imitator* (pl. 18, fig. 7), which would then give rise to the *Viator* line, beginning with the Early Miocene *Dermomurex (Viator) darraghi* Vokes, 1985, continuing through the Middle Miocene *D.(T.) asteriscus* (Tate, 1888), on to the living *D.(T.) antonius* Vokes, 1974. No unexplainable long distance transport is required; the only puzzling aspect is the extreme similarity of the two Late Oligocene species, which must have been derived from an as-yet unknown common ancestor.

Another species described at the same time, *D.(T.) cretaceus* Vokes (1985b, p. 52, pl. 2, figs. 4-6) from the Early Oligocene of Australia, is probably ancestral to the living *D.(T.) bobyini* Kosuge, 1984, which differs from the type species, *D.(T.) infrons*, in being more angulate, with a strong fold at the shoulder.

The other two Indo-Pacific species *D.(T.) infrons* and *D.(T.) wareni* Houart, 1991, recently described from New Caledonia, are believed to be descendants of the European Oligocene *D.(T.) cotteavi* (Meunier, 1880), and the single living eastern Pacific form, *D.(T.) myrakeenae* (Emerson and D'Attilio, 1970), is presumed to be derived from the American Oligocene *D.(T.) cookei* Vokes. At this time there are no known species of *Takia* living in the Atlantic Ocean – but given the rate of discovery of new species of *Dermomurex* in the Caribbean of late, one may yet appear.

DERMOMUREX (TAKIA) COOKEI Vokes
Plate 18, figures 1, 2

Dermomurex (Takia) cookei MacNeil MS *in*

VOKES, 1975, Tulane Stud. Geol. Paleont., v. 11, no. 3, p. 149, pl. 5, figs. 2-4; MACNEIL and DOCKERY, 1984, Mississippi Bur. Geol., Bull. 124, p. 127, pl. 4, figs. 15, 18, 19 (holotype), 20 (paratype A), pl. 18, figs. 8, 14, 20 (paratype B).

Holotype: USNM 647449; height 20.5 mm, diameter 11 mm.

Type locality: USGS 15085, Red Bluff Formation; Chickasawhay River, about one mile [1.6 km] southwest of Hiwannee, Wayne County, Mississippi (= TU 226).

Occurrence: Red Bluff and Mint Springs formations, Mississippi.

Figured specimens: Fig. 1, USNM 647449 (holotype). Fig. 2, USNM 462697; height 14.4 mm, diameter 7.6 mm; locality MGS 37, Red Bluff, Chickasawhay River, Wayne County, Mississippi (= TU 1289). Additional locality: TU 1289.

Discussion: In the collections of the Mississippi Geological Survey there are several additional examples of *D.(T.) cookei*, all from the general type area on the Chickasawhay River. One of these is a juvenile in which the intritacalx is unusually well preserved (pl. 18, fig. 2), showing that when unbroken it is nearly smooth and when broken relatively large spiral tubes are exposed.

DERMOMUREX (TAKIA) PORTELLI
Vokes, n. sp.
Plate 18, figures 3, 4

Dermomurex (Viator) aff. *D.(V.) sexangulus* (Dall). ROSSBACH and CARTER, 1991, Jour. Paleontology, v. 65, no. 1, p. 98, text-figs. 9.8, 9.9.

Description: Shell large for the genus, body whorl greatly inflated. Protoconch and early whorls not known; at least six teleoconch whorls in the adult. Axial ornamentation on all early whorls of seven rounded varices, increasing to nine on adult body whorl (gerontic?). Each varix abutted against corresponding varix of preceding whorl but slightly abapertural to it, forming a spiral line up the spire whorls. Spiral ornamentation of two ill-defined cords on spire whorls, six major cords on body whorl, plus several smaller cords on sub-sutural ramp and siphonal canal, all crossing both varices and intervarical spaces with equal strength. Superimposed upon the larger cords tertiary threads covering the entire shell surface. Suture impressed between varices creating deep pits. Aperture rounded, inner lip smooth, appressed at posterior end, with a wide, flaring inductura developed on anterior portion. Inner side of outer lip with seven strong lirae, corresponding to the spaces between the spiral cords. Siphonal canal long, slightly recurved at distal end, almost sealed over but open by a narrow slit. In life, shell covered by a thick intritacalx, but only remnant patches remaining in fossil state.

Holotype: UF 32456; height 28.1 mm, diameter 17.2 mm.

Type locality: Suwannee Limestone; Terramar (SW 1/4 Sec. 10, T26S, R22E), Polk County, Florida.

Etymology of name: In honor of Roger W. Portell, Florida Museum of Natural History, Gainesville, Florida, who collected the type specimen.

Occurrence: Suwannee Limestone, Florida; River Bend Formation, North Carolina.

Figured specimens: Fig. 3, UF 32456 (holotype). Fig. 4, UNC 14037-339 (paratype); height (incomplete) 22.3 mm, diameter (incomplete) 15.7 mm; locality Martin Marietta Quarry, about 1.6 km northwest of New Bern, Craven County, North Carolina.

Discussion: Rossbach and Carter (1991), in a study of the mollusks of the River Bend Formation (= part of the Trent Formation of older literature), determined that the fauna was of Vicksburgian or at least pre-Chickasawhayan age for exposures at New Bern, Craven County, North Carolina. They figured two examples of a muricid gastropod, which they assigned to *Dermomurex (Viator)* aff. *D.(V.) sexangulus*, noting that the latter "has a more step-like appearance to its spire and more robust spiral cords with larger interspaces" (*ibid.*, p. 98).

One of their two figured specimens is the same species as a specimen collected from the Suwannee Limestone of Florida, here described as *D.(T.) portelli*, confirming Rossbach and Carter's age determination for the New Bern beds. The second specimen (UNC 14037-139) is not as well preserved (see pl. 18, fig. 5) and does not show the deep pits along the suture characteristic of this new species. However, on the basis of size, number of varices, number of spiral whorls, etc., I can find no basis to separate the two examples. It is probable that the second specimen is simply atypical but, for this reason, I decided not to make it a paratype.

From the slightly younger *D.(T.) sexangulus*, this new species differs in being less massive, having more numerous spiral cords, a longer siphonal canal, and a more expanded inductura. This latter feature and the elongate lirae on the inner side of

the outer lip are similar to the same structures in the younger *D.(T.) vaughani*, from the Chipola Formation. In general aspect, *D. portelli* resembles the latter species, but has a higher spire and a shorter, more recurved siphonal canal.

DERMOMUREX (TAKIA) SEXANGULUS (Dall)
Plate 18, figure 6

Dermomurex (Viator) sexangulus (Dall). VOKES, 1975, Tulane Stud. Geol. Paleont., v. 11, no. 3, p. 152, pl. 6, figs. 1 (holotype), 2 (holotype, *Murex gilletteorum*).

Dermomurex (Takia) sexangulus (Dall). VOKES, 1985, Malac. Soc. Australia, Jour., v. 7, nos. 1-2, p. 53, pl. 2, fig. 2 (holotype, *Murex gilletteorum*).

Synonym:

Murex (Panamurex) gilletteorum VOKES, 1963, Tulane Stud. Geol., v. 1, no. 3, p. 160, pl. 2, fig. 1.

Holotype: USNM 165086; height 21.4 mm, diameter 14 mm.

Type locality: Tampa Limestone; Ballast Point, Tampa Bay, Hillsborough County, Florida.

Occurrence: Tampa Limestone, Florida; "Silverdale Beds" (= Silverdale Formation = Haywood Landing Member, Belgrade Formation), North Carolina.

Figured specimen: USNM 644377 (holotype, *Murex gilletteorum*); height 43.5 mm, diameter 26 mm; locality TU 562.

Discussion: As is discussed further under the species *Pterynotus (Purpurellus)*

PLATE 18

Figures Page

1, 2. *Dermomurex (Takia) cookei* MacNeil MS *in* Vokes 80
1. (X 3) USNM 647449 (holotype); height 20.5 mm, diameter 11 mm.
Locality: USGS 15085, Chickasawhay River, Wayne County, Mississippi (= TU 226); Red Bluff Formation.
2. (X 4) USNM 462697; height 14.4 mm, diameter 7.6 mm.
Locality: MGS 37, Red Bluff, Chickasawhay River, Wayne County, Mississippi (= TU 1289); Red Bluff Formation.

3, 4. *Dermomurex (Takia) portelli* Vokes, n. sp. (X 2) 81
3. UF 32456 (holotype); height 28.1 mm, diameter 17.2 mm.
Locality: Terramar, Polk County, Florida; Suwannee Limestone.
4. UNC 14037-339 (paratype); height (incomplete) 22.3 mm, diameter (incomplete) 15.7 mm.
Locality: Martin Marietta Quarry, New Bern, Craven County, North Carolina; River Bend Formation.

5. (?) *Dermomurex (Takia) portelli* Vokes, n. sp. (X 2) 81
UNC 14037-139; height (incomplete) 22.8 mm, diameter (incomplete) 16.2 mm.
Locality: Martin Marietta Quarry, New Bern, Craven County, North Carolina; River Bend Formation.

6. *Dermomurex (Takia) sexangulus* (Dall) (X 1 1/4) 82
USNM 644377 (holotype, *Murex gilletteorum* Vokes); height 43.5 mm, diameter 26 mm.
Locality : TU 562, North Carolina; "Silverdale Beds" (= Haywood Landing Member, Belgrade Formation).

7. *Dermomurex (Takia) imitator* Vokes (X 2) 80
NMV P 74074 (holotype); height 28.4 mm, diameter 19.6 mm.
Locality: Bird Rock Cliffs, Torquay, Victoria, Australia; Jan Juc Formation.

8. *Dermomurex (Takia) curviductus* Vokes (X 1 1/4) 84
USNM 647452; height 51.8 mm, diameter 34.5 mm.
Locality: TU 830, Florida; Chipola Formation.

9. *Dermomurex (Takia) vaughani* (Maury) (X 1 1/2) 84
USNM 647450; height 35.5 mm, diameter 22.7 mm.
Locality: TU 825, Florida; Chipola Formation.

10. *Dermomurex (Takia) infrons* Vokes (X 2) 84
ANSP 241534; height 29.8 mm, diameter 14.6 mm.
Locality: Tosa, Japan; Recent.

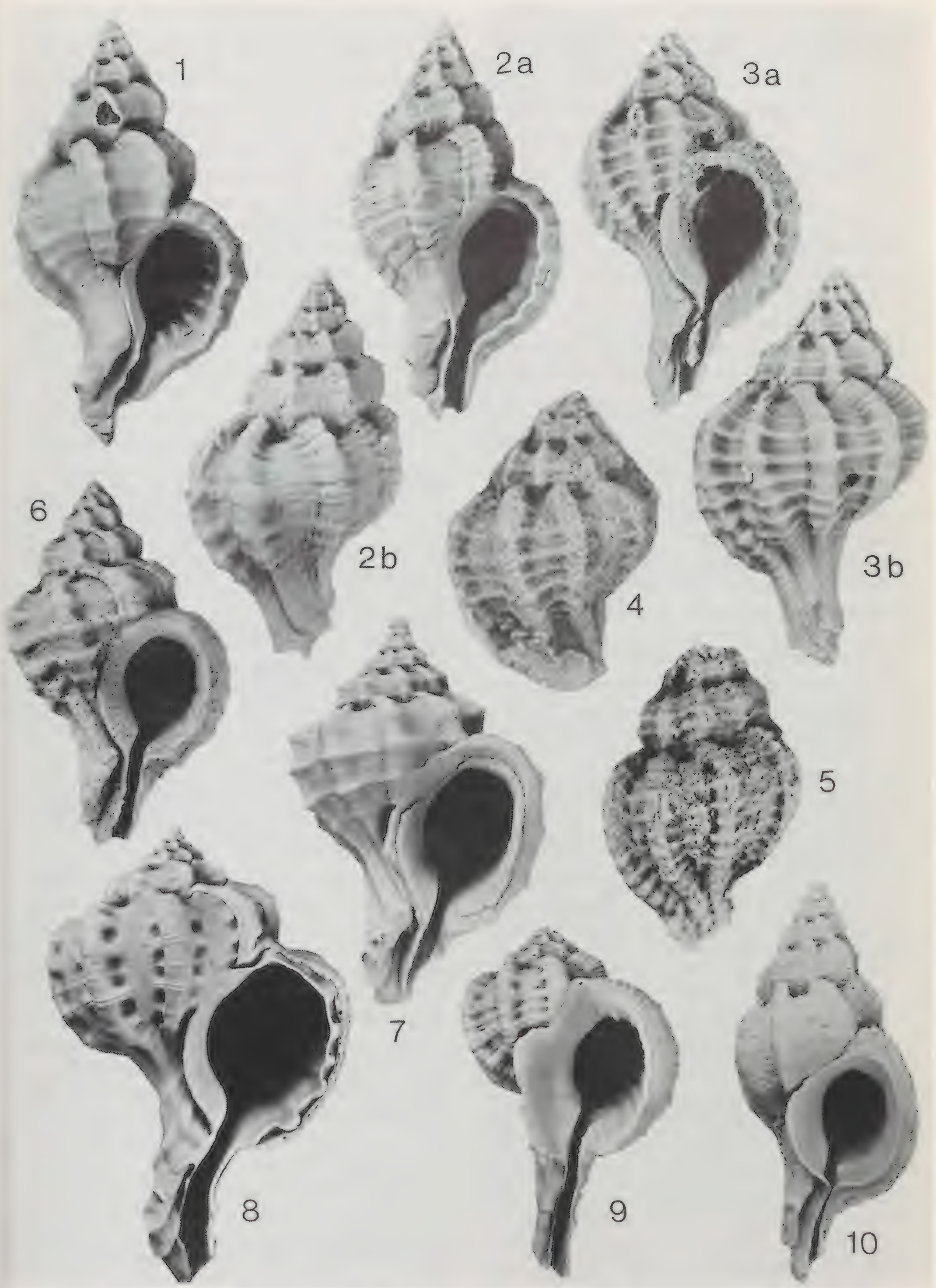

PLATE 18

repetiti Vokes (above), the beds at Silverdale, North Carolina, are now referred either to the Silverdale Formation (Baum *et al.*, 1978) or to the Haywood Landing Member of the Belgrade Formation (Ward *et al.*, 1978), but in either case are of Late Oligocene (Chickasawhayan) age. Otherwise, there is no new information on this species; no additional material has been collected.

Previously, I have vacillated between placing this species in *Takia* (Vokes, 1971b, p. 97) and *Viator* (Vokes, 1974, p. 7; 1975, p. 152). As stated in the discussion of the subgenus *Takia* (above), work on the Australian species of these two groups (Vokes, 1985b) has convinced me that all of the American species are better referred to *Takia*, with the name *Viator* restricted to the Australian members of the group.

As noted above, the specimens referred to *Dermomurex (V.)* aff. *D.(V.) sexangulus* from the River Bend Formation, New Bern, North Carolina, by Rossbach and Carter (1991, p. 98) are referred to *D.(T.) portelli*, n. sp.

Dermomurex (Takia) curviductus Vokes
Plate 18, figure 8

Dermomurex (?Viator) curviductus VOKES, 1975, Tulane Stud. Geol. Paleont., v. 11, no. 3, p. 156, pl. 7, figs. 2, 3.

Dermomurex (Takia) curviductus Vokes. VOKES, 1985, Malac. Soc. Australia, Jour., v. 7, nos. 1-2, p. 53.

Holotype: USNM 647452; height 51.8 mm, diameter 34.5 mm.

Type locality: TU 830, Chipola Formation; Tenmile Creek, at power line crossing about one mile [1.6 km] west of Chipola River (SE 1/4 Sec. 12, T1N, R10W), Calhoun County, Florida.

Occurrence: Chipola Formation, Florida.

Figured specimen: USNM 647452 (holotype).

Discussion: Referring the American species of this group to the subgenus *Takia* solves some problems with the placement of this unusual species that clearly resembles *D.(T.) vaughani* but has a recurved canal rather than the straight canal of the latter. If *D. vaughani* is considered aberrant, reflecting a convergent resemblance to the Australian species of *Viator*, then *D. curviductus* more easily can be placed with the other species of *Takia*, which are characterized by recurved siphonal canals.

The low spire of these two Chipola species is markedly different from most species of *Takia*, which typically are rather high spired (see pl. 18, fig. 10, *D. infrons*, type of *Takia*). The two exceptions to this are the Australian *D.(T.) imitator* (see pl. 18, fig. 7) and the Italian species *D. taurinensis* (Michelotti, 1841), which as noted previously (Vokes, 1975, p. 156, pl. 7, fig. 5) is extremely close to *D. curviductus*. These four species possibly could be separated as a different subgenus but I prefer to consider all four simply as unusual examples of *Takia*.

There have been no additional specimens taken since this species was named and no new information is available.

Dermomurex (Takia) vaughani (Maury)
Plate 18, figure 9

Dermomurex (Viator) vaughani (Maury). VOKES, 1975, Tulane Stud. Geol. Paleont., v. 11, no. 3, p. 153, pl. 7, figs. 1, 4.

Dermomurex (Takia) vaughani (Maury). VOKES, 1985, Malac. Soc. Australia, Jour., v. 7, nos. 1-2, p. 53.

Holotype: PRI 3561; height 22.5 mm, diameter 14 mm.

Type locality: Chipola Formation; "Bailey's Ferry," = TU 554, east bank of Chipola River, at power line crossing (SW 1/4 Sec. 17, T1N, R9W), Calhoun County, Florida (designated by Vokes, 1975, p. 153).

Occurrence: Chipola Formation, Florida.

Figured specimen: USNM 647450; height 35.5 mm, diameter 22.7 mm; locality TU 825. Additional localities: TU 998, 1048.

Discussion: It is *D.(T.) vaughani*, with its long straight canal that causes the greatest problem in subgeneric assignment. In this character it closely resembles *D. antonius* Vokes, 1974, type of *Viator* Vokes, 1974, but the large expanded inductura differs strikingly from that species, which has a small oval aperture with an appressed inner lip. As discussed above, I have concluded that the resemblance to *Viator* is due to convergence between the American and Australian lines descending from the two similar Oligocene species *D. sexangulus* and *D. imitator*.

In *D.(T.) vaughani* the inductura is even more expanded than in *D.(T.) infrons*, type of *Takia* (see pl. 18, fig. 10). The aperture also differs in the presence of lirations on the inner side of the outer lip, rather

than the denticles developed in *Takia*, and the spire is much lower in *D. vaughani* than in *D. infrons*. It is obvious that the two forms are only distantly related, with the New World and Old World branches of the line having been separated since the Early Tertiary. Nevertheless, as indicated above, it is better to consider this species as an aberrant member of the group rather than to erect yet another subgenus.

Genus CALOTROPHON Hertlein and Strong, 1951

Calotrophon HERTLEIN and STRONG, 1951, Mollusks West Coast of Mexico and Central Amer., pt. 10, *in* Zoologica, v. 36, p. 87.

Type species: *Calotrophon bristolae* Hertlein and Strong, 1951 (= *Tritonalia turrita* Dall, 1919), by original designation.

Discussion: The relationship of *Calotrophon* to members of the genus *Panamurex* has been discussed above. There seems little question that *Calotrophon* is derived from a *Panamurex* ancestor, the Early and Middle Miocene species *C. phagon* could be placed equally well in either genus (as in my previous treatment of the two groups). Based upon phylogeny it would be better to place the genus *Calotrophon* immediately after *Poirieria (Panamurex)*. However, I prefer to follow the same sequence presented in the earlier papers, thus *Calotrophon* and *Attiliosa* will continue to be placed at the end of the subfamily.

The genus *Calotrophon* is a small group, with previously only four taxa in the western Atlantic, plus the eastern Pacific type of the genus, *C. turritus* (Dall). To this, we now add two Miocene species previously placed in *Poirieria (Panamurex)* and one other Pleistocene species from the southern Caribbean. However, with additional material from the Pleistocene Moín Formation of Costa Rica, I now refer *C. ascensus* Vokes (1976b, p. 110, pl. 6, figs. 1, 2) to the muricopsine genus *Acanthotrophon*. Thus, the count is six species, ranging in age from Early Miocene to Recent.

CALOTROPHON PHAGON (Gardner)
Plate 19, figure 1

Poirieria (Panamurex) phagon (Gardner). VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 38, pl. 6, fig. 7; VOKES, 1976, Tulane Stud. Geol. Paleont., v. 12, no. 3, p. 103, pl. 1, fig. 5.

Holotype: USNM 371856; height 16.5 mm, diameter 9.2 mm.

Type locality: USGS 2646, Oak Grove Sand; Oak Grove, Yellow River, Okaloosa County, Florida (= TU 91).

Occurrence: Oak Grove Sand and Shoal River Formation, Florida.

Figured specimen: USNM 646430; height 20 mm, diameter 11.5 mm; locality TU 91. Additional locality: TU 69A.

Discussion: Calotrophon phagon was described from the Oak Grove Sand, considered to be a shallow-water facies of the Chipola Formation, and we have two examples from the Shoal River Formation (TU 69A), also a near-shore sand. Although the Oak Grove and the Chipola are the same age we have not collected any specimens of *C. phagon* in the Chipola Formation.

Previously (Vokes, 1970, p. 39), I assigned this species to *Poirieria (Panamurex)* and suggested that it might be a shallow equivalent of *P. mauryae*, but as all of the specimens are consistent in lacking any trace of spines on the siphonal canal and, with the discovery of the transitional species *C. venezuelanus* (below), it is more likely that *C. phagon* represents the earliest species of the *Calotrophon* group.

CALOTROPHON HUTCHISONI Jung
Plate 19, figures 2, 3

Poirieria (Panamurex) hutchisoni (Jung). VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 44; VOKES, 1976, Tulane Stud. Geol. Paleont., v. 12, no. 3, p. 103, pl. 1, figs. 3 (paratype), 4 (holotype).

Holotype: USNM 645494; height 16.6 mm, diameter 9.4 mm.

Type locality: USGS 271178, Melajo Clay; Melajo River, west of Matura Bay, Trinidad.

Occurrence: Melajo Clay, Trinidad.

Figured specimens: Fig. 2, USNM 645495 (paratype); height 15.6 mm, diameter 9 mm; locality USGS 18399, Melajo River, Trinidad. Fig. 3, USNM 645494 (holotype).

Discussion: When described by Jung (1969, p. 494, pl. 50, figs. 7-9) this species was assigned provisionally to the genus *Calotrophon*. Subsequently (Vokes, 1970, p. 44; 1976b, p. 103), I placed it in *Poirieria (Panamurex);* however, with the discovery of *C. venezuelanus* (below) I now believe that Jung was correct. Although *P. hutchisoni* has spinose early whorls of the teleoconch (pl. 19, fig. 3) and rugae on the inner

lip, the overall morphology is more similar to the later species of *Calotrophon*. It is known only from the type lot taken from the Late Miocene Melajo Clay, Trinidad.

CALOTROPHON OSTREARUM (Conrad)
Plate 19, figures 4-9

Calotrophon ostrearum (Conrad). VOKES, 1976, Tulane Stud. Geol. Paleont, v. 12, no. 3, p. 105, pl. 1, figs. 6-9; pl. 2, figs. 1-6; pl. 3, figs. 4-9 only (figs. 1-3 = *C. ostrearum conradi*); pl. 4, figs. 1-11; pl. 5, figs. 1-11; RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 30, pl. 3, fig. 4; VOKES, 1984, Shells and Sea Life, v. 16, no. 1, p. 212, pl. 1, fig. 24.

Synonyms:

Fusus mexicanus REEVE, 1848, Conchologia Iconica, v. 4, *Fusus*, pl. 19, fig. 77; BULLOCK, 1976, Tulane Stud. Geol. Paleont., v. 12, no. 3, p. 133, pl. 1, figs. 1-5 (as *Calotrophon ostrearum* on plate explanation).

Urosalpinx floridana CONRAD, 1869, Amer. Jour. Conch., v. 5, p. 106, pl. 12, fig. 4.

Muricidea floridana var. *attenuata* DALL, 1890, Wagner Free Inst. Sci., Trans., v. 3, pt. 1, p. 149.

Cantharus (Pseudosalpinx) perplexus OLSSON and HARBISON, 1953, Acad. Nat. Sci. Phila., Mon. 8, p. 255, pl. 37, figs. 1, 1a.

Calotrophon emilyae PETUCH, 1988, Neogene Hist. Trop. Amer. Moll., p. 55, pl. 18, figs. 7, 8.

Calotrophon libertiensis (Mansfield). PETUCH, 1988, Neogene Hist. Trop. Amer. Moll., pl. 18, figs. 9, 10 (not of Mansfield).

Lectotype (*Urosalpinx floridana* Conrad): ANSP 36551 (designated by McLean and Emerson, 1970, p. 60); height 29.2 mm (*fide* Olsson and Harbison, 1953, expl. pl. 37).

PLATE 19

Figures — Page

1. *Calotrophon phagon* (Gardner) (X 2 1/2) 85
   USNM 646430; height 20 mm, diameter 11.5 mm.
   Locality: TU 91, Florida; Oak Grove Sand.
2, 3. *Calotrophon hutchisoni* Jung 85
   2. (X 3) USNM 645495 (paratype); height 15.6 mm, diameter 9 mm.
      Locality: USGS 18399, Melajo River, Trinidad; Melajo Clay.
   3. (X 10) USNM 645494 (holotype); height 16.6 mm, diameter 9.4 mm.
      Locality: USGS 271178, Melajo River, Trinidad; Melajo Clay.
4-9. *Calotrophon ostrearum* (Conrad) (X 2) 86
   4. USNM 240644; height 27.9 mm, diameter 14.4 mm.
      Locality: TU 932, Florida; Fruitville Formation.
   5. USNM 240659; height 27.4 mm, diameter 13.2 mm.
      Locality: TU 519, Florida; Caloosahatchee Formation.
   6. USNM 462698; height 22.3 mm, diameter 12.3 mm.
      Locality: TU 1000, Florida; Fruitville Formation.
   7. FSBC I 11240; height 23.2 mm, diameter 14 mm.
      Locality: "Hourglass" Station K, off Ft. Myers, Florida, in 20 fathoms [37 meters]; Recent.
   8. USNM 711108; height 22.4 mm, diameter 11.6 mm.
      Locality: TU R-9, Florida; Recent.
   9. USNM 240660; height 24.6 mm, diameter 12 mm.
      Locality: TU 519, Florida; Caloosahatchee Formation.
10, 11. *Calotrophon ostrearum conradi* (Mansfield) (X 2) 88
   10. USNM 240652; height 23.4 mm, diameter 11.8 mm.
      Locality: TU 60, Florida; Jackson Bluff Formation.
   11. USNM 240655; height 24.4 mm, diameter 12.8 mm.
      Locality: TU 1000, Florida; Fruitville Formation.
12. *Calotrophon venezuelanus* Vokes, n. sp. (X 3) 89
   NMB H 17392 (holotype); height 14.3 mm, diameter 7.7 mm.
   Locality: NMB 17512, Venezuela; Mare Formation.
13. *Calotrophon andrewsi* Vokes (X 2 1/2) 89
   USNM 711111 (holotype); height 20 mm, diameter 11.4 mm.
   Locality: TU R-44, Quintana Roo, Mexico; Recent.

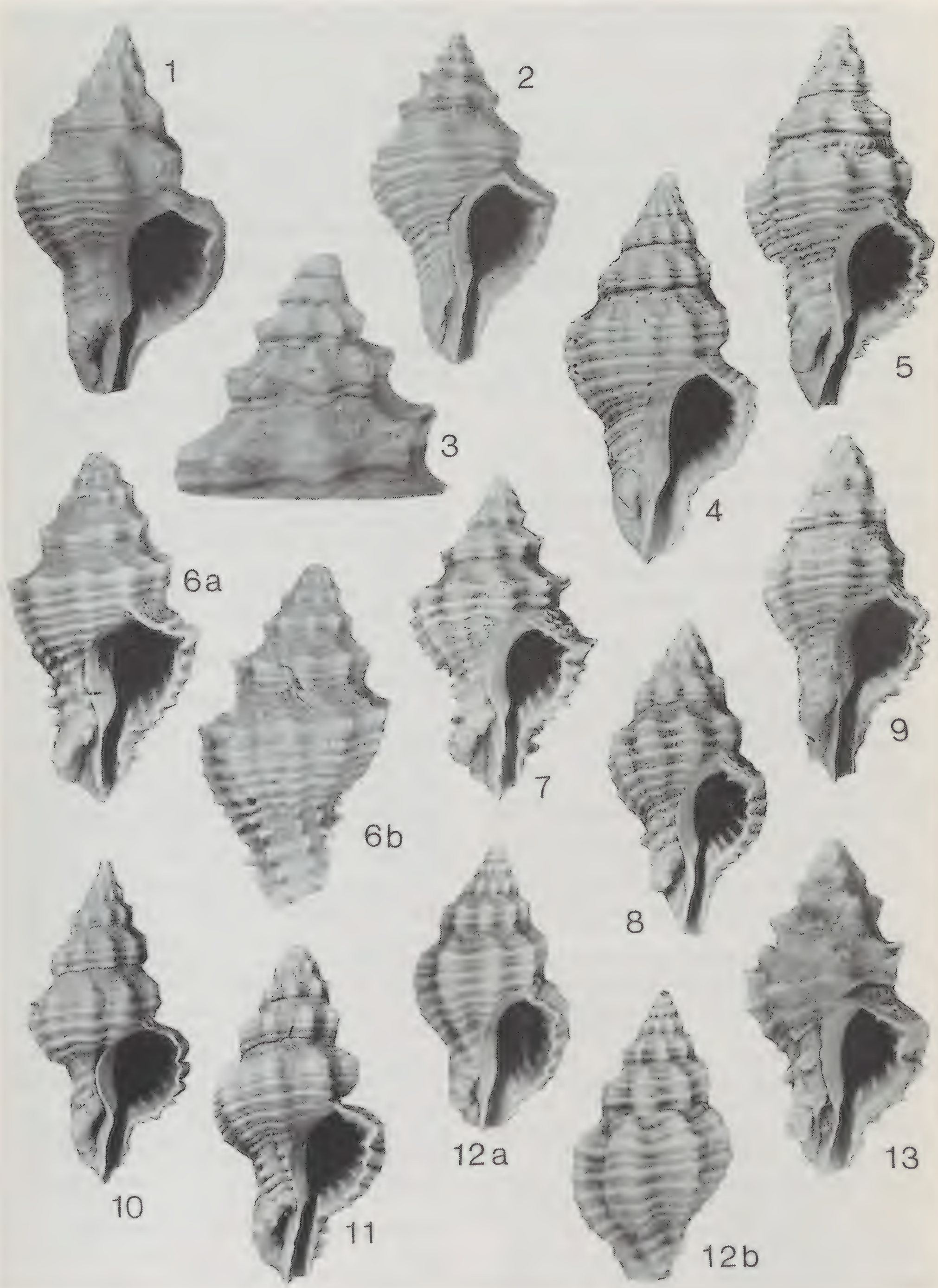

PLATE 19

Type locality: Tampa Bay, Florida.

Occurrence: Duplin Formation, North Carolina; Waccamaw Formation, South Carolina; Pinecrest, Tamiami, Fruitville (= "Pinecrest Beds"), Caloosahatchee, Bermont, Anastasia, and Ft. Thompson formations, Florida. Recent, Florida and northwestern Yucatan Peninsula.

Figured specimens: Fig. 4, USNM 240644; height 27.9 mm, diameter 14.4 mm; locality TU 932. Fig. 5, USNM 240659; height 27.4 mm, diameter 13.2 mm; locality TU 519. Fig. 6, USNM 462698; height 22.3 mm, diameter 12.3 mm; locality TU 1000. Fig. 7, FSBC I 11240; height 23.2 mm, diameter 14 mm; locality "Hourglass" Station K, off Ft. Myers, Florida, in 20 fathoms [37 meters]. Fig. 8, USNM 711108; height 22.4 mm, diameter 11.6 mm; locality TU R-9. Fig. 9, USNM 240660; height 24.6 mm, diameter 12 mm; locality TU 519. Additional localities: TU 1491, 1492, 1493.

Discussion: The variability of this species was documented by numerous specimens ranging in age from Middle Pliocene to Recent (see Vokes, 1976b, p. 105). As a result, there are numerous synonyms. Since that discussion another name, *C. emilyae,* has been proposed by Petuch (1988, p. 55, pl. 18, figs. 7, 8) for an attenuated example from the Tamiami Formation at Mule Pen Quarry (= TU 1177). His type specimen is identical to the specimen from the Duplin Formation, North Carolina, figured previously (Vokes, 1976b, pl. 3, fig. 9), and differs only slightly from the example figured (*ibid.*, pl. 3, fig. 8) as being nearest to the dimensions of the form named *"attenuata"* by Dall (1890, p. 149). The proportions of Petuch's holotype (height 19 mm, diameter 9 mm) are very close to those of *"attenuata"* (height 29 mm, diameter 13 mm).

Petuch compared his new species only to *C. conradi* (Mansfield) and stated: "The body whorl of *C. emilyae* is much more tapered than that of *C. conradi,* blending directly into the siphonal canal." As this is the trait that distinguishes *C. conradi* from *C. ostrearum* (noted previously; Vokes, 1976b, p. 109), he should have compared his specimen with *C. ostrearum.*

In the same work, he figured a specimen (Petuch, 1988, pl. 18, figs. 9, 10) from the "Pliocene Everglades Pseudoatoll" (? = TU 1177; all other species cited, pp. 55-57, are from that locality) identified as *Calotrophon libertiensis* (Mansfield). As discussed earlier (Vokes, 1976b, p. 109), the latter is a synonym of *C. ostrearum conradi,* but Petuch's figured specimen is a "typical" (if such a thing exists) example of *C. ostrearum,* most similar to the paratype of *Urosalpinx floridana* Conrad, figured by Olsson and Harbison (1953, pl. 37, fig. 2a). As may be seen by comparing his illustration with pl. 19, fig. 10 herein, Petuch's specimen lacks the strong basal constriction that separates the subspecies.

CALOTROPHON OSTREARUM CONRADI
(Mansfield)
Plate 19, figures 10, 11

Calotrophon ostrearum conradi (Mansfield). VOKES, 1976, Tulane Stud. Geol. Paleont., v. 12, no. 3, p. 109, pl. 2, figs. 7-9.

Calotrophon ostrearum (Conrad). VOKES, 1976, Tulane Stud. Geol. Paleont., v. 12, no. 3, p. 105 (in part), pl. 3, figs. 1-3 only.

Synonym:

Muricidea floridana libertiensis MANSFIELD, 1930, Florida Geol. Surv., Bull. 3, p. 86, pl. 11, fig. 8.

Not *Calotrophon libertiensis* (Mansfield). PETUCH, 1988, Neogene Hist. Trop. Amer. Moll., pl. 18, figs. 8, 9 (= *C. ostrearum*).

Holotype: USNM 370203; height 30 mm, diameter 16 mm.

Type locality: Jackson Bluff Formation; Harvey's Creek, Leon County, Florida.

Occurrence: Jackson Bluff and Fruitville (= "Pinecrest Beds") formations, Florida.

Figured specimens: Fig 10, USNM 240652; height 23.4 mm, diameter 11.8 mm; locality TU 60. Fig. 11, USNM 240655; height 24.4 mm, diameter 12.8 mm; locality TU 1000.

Discussion: The identification of Pliocene specimens of this genus as *C. ostrearum* is completely arbitrary. Certain examples, such as those from northern Florida in the Jackson Bluff Formation (TU 60), have been separated as the subspecies *C. ostrearum conradi,* on the basis of the constricted siphonal canal. Using this criterion, some of the contemporaneous examples from farther south at Sarasota (TU 1000), although previously placed in *C. ostrearum* (Vokes, 1976b), should be assigned to *C. ostrearum conradi.* This is not surprising, as there are numerous other species in common between the two areas, which are only about 260 miles [420 km] apart.

However, at this locality there are also examples of *C. ostrearum* s.s. (see pl. 19,

fig. 6) creating a taxonomic problem, as we cannot have subspecies living together. Other early specimens from the lower Pinecrest Beds (= Fruitville Formation; TU locs. 730, 932) also are somewhat atypical (see Vokes, 1976b, pl. 2, figs. 1-6) and presumably gave rise to both subspecies, as they are morphologically intermediate. There may be a stratigraphic separation between the two subspecies at Sarasota, as the "*conradi*" examples were collected earlier when the pits were to the south of their present location (the old Warren Bros. pit). The "*ostrearum*" examples are from the newer APAC pits. Until we have additional information, I will treat the two forms as stratigraphic subspecies.

CALOTROPHON VENEZUELANUS Vokes, n. sp.
Plate 19, figure 12

Description: Shell with six teleoconch whorls, protoconch unknown. Axial ornamentation initially of nine angulate ridges, gradually decreasing in number to seven heavy, rounded varices on body whorl. Varices unornamented except for welts raised by crossing of spiral cords, last few varices delineated by a raised line on the adapertural side representing position of former aperture. Shell surface covered by numerous axial growth lines, best seen just anterior to suture. Spiral ornamentation not developed until about third teleoconch whorl, initially of two cords: one at shoulder and one between shoulder and suture. Gradually two secondary cords added on shoulder ramp and one additional cord added between two major cords on spire whorls. Body whorl with six major cords and another two on siphonal canal, plus two weaker cords on shoulder and one weaker one intermediate between two major cords at shoulder and periphery. Suture markedly appressed, sinuated by varices of preceding whorl; just anterior to suture a depressed groove on shoulder ramp, paralleling suture and forming almost a double suture line. Aperture oval; inner lip smooth, appressed the entire length, with two extremely weak nodules at anterior end. Outer lip crenulated by spiral cords, especially that at shoulder; inner side with about nine lirae, corresponding to spaces between external spiral cords. Siphonal canal short, broad, slightly recurved at distal end, forming a small siphonal fasciole.

Holotype: NMB H 17392; height 14.3 mm, diameter 7.7 mm.

Type locality: NMB 17512, Mare Formation (type locality); Cabo Blanco, Dto. Federal, Venezuela.

Etymology of name: For the country from which it comes.

Occurrence: Mare Formation, Venezuela.

Figured specimen: NMB H 17392 (holotype).

Discussion: In the Gibson Smith Collection at the Naturhistorisches Museum, Basel, Switzerland, there is a single example of *Calotrophon* that is similar to *C. ostrearum* but has a shorter siphonal canal. Like the two Miocene species now assigned to *Calotrophon,* this new species has very faint rugae at the base of the inner lip. It is the combination of these relict rugae in a shell otherwise unmistakably *Calotrophon* that caused me to reevaluate my former placement of the Miocene species.

The beds at Cabo Blanco were considered by Weisbord (1962) to be of Early Pliocene age. But, as discussed above under the species *Poirieria (Panamurex) recticanalis,* planktic foraminifera indicate that the Playa Grande Formation (which underlies the Mare Formation) is Pleistocene in age. Also, as noted above, this famous locality has been destroyed by the Caracas Airport expansion, and it is unlikely that we will ever find any more examples of this new species.

CALOTROPHON ANDREWSI Vokes
Plate 19, figure 13

Calotrophon andrewsi VOKES, 1976, Tulane Stud. Geol. Paleont., v. 12, no. 3, p. 110, pl. 6, figs. 3-6.

Holotype: USNM 711111; height 20 mm, diameter 11.4 mm.

Type locality: TU R-44, Isla Mujares, Quintana Roo, Mexico.

Occurrence: Recent only, southwestern Florida to northeastern Yucatan.

Figured specimen: USNM 711111 (holotype).

Discussion: We have no new information on this species, which is rare in collections perhaps due to continued confusion with *C. ostrearum.*

Genus ACANTHOLABIA
Olsson and Harbison, 1953

Acantholabia OLSSON and HARBISON, 1953, Acad. Nat. Sci. Phila., Mon. 1, p. 251.

Type species: *Acantholabia floridana* Olsson and Harbison, 1953, by original designation.

Discussion: In my sequence of papers on the Cenozoic Muricinae the genus *Acantholabia* was not included, for I placed it with the group of *Urosalpinx, Eupleura,* etc., in the Ocenebrinae, as originally suggested by Olsson and Harbison (1953, p. 252).

However, additional material has indicated that it is closer to *Calotrophon*.

This genus, which initially contained but one fossil species represented by only a few specimens, and with no living counterpart, is very distinctive with its strong labral tooth (see pl. 20, figs. 3b, 4b). But except for that feature the overall morphology of the shell is not much different from *Calotrophon*. Therefore, it is placed here, provisionally; a placement that could be changed by the discovery of living animals.

Acantholabia floridana
Olsson and Harbison
Plate 20, figures 1-3

Acantholabia floridana OLSSON and HARBISON, 1953, Acad. Nat. Sci. Phila., Mon. 1, p. 252, pl. 33, fig 10.

Not *Acantholabia floridana* Olsson and Harbison. PETUCH, 1988, Neogene Hist. Trop. Amer. Moll., p. 51, pl. 12, figs. 13, 14; PETUCH, 1991, W.H. Dall Paleont. Resh. Center, Spec. Publ. 1, p. 28, pl. 4, fig. 12 [same specimen as 1988 = *A. sarasotaensis* Petuch].

Holotype: ANSP 19307; height 25.7 mm, diameter 14.5 mm.

Type locality: Caloosahatchee Formation; North St. Petersburg, 70th Ave. at 9th St. N., Pinellas County, Florida (= TU 68).

Occurrence: Tamiami and Caloosahatchee formations, Florida.

Figured specimens: Fig. 1, ANSP 19307 (holotype). Fig. 2, ANSP 19307A (paratype); height 22.6 mm, diameter 12.6 mm; locality same as holotype. Fig. 3, USNM 462699; height 21.6 mm, diameter 12.3 mm; locality TU 1177.

Discussion: This unusual species is rare. The three figured specimens are the only ones known to me. Apparently there are no examples in the Hoerle Collection at the U.S. National Museum. The single specimen from the Tamiami Formation (TU 1177) is so different from the type specimens that it may be a new species, or the genus may be quite variable, which can be

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PLATE 20

Figures — Page

1-3. *Acantholabia floridana* Olsson and Harbison (X 2) 90
1. ANSP 19307 (holotype); height 25.7 mm, diameter 14.5 mm.
2. ANSP 19307A (paratype); height 22.6 mm, diameter 12.6 mm.
Locality of both: North St. Petersburg, Florida (= TU 68); Caloosahatchee Formation.
3. USNM 462699; height 21.6 mm, diameter 12.3 mm.
Locality: TU 1177, Florida; Tamiami Formation.
4. *Acantholabia sarasotaensis* Petuch (X 2) 92
CM 35638 (holotype); height 30.9 mm, diameter 15 mm.
Locality: APAC quarry, Sarasota, Florida (= TU 1000); "Pinecrest Beds" (= Fruitville Formation).
5-8. *Attiliosa aldridgei* (Nowell-Usticke) 93
5. (X 2) USNM 869515; height 19.1 mm, diameter 12.8 mm.
Locality: TU R-369, Costa Rica; Recent.
6. (X 1 1/2) Sunderland Coll.; height 29.7 mm, diameter 18.3 mm.
Locality: Bimini, B.W.I., in 6-9 meters; Recent.
(Specimen in fig. 6a not whitened to show color pattern)
7. (X 1 1/2) USNM 462692; height 31.5 mm, diameter 20.1 mm.
Locality: TU 1215, Dominican Republic; Gurabo Formation.
8. (X 4) USNM 323924; height 10.8 mm, diameter 6.9 mm.
Locality: TU 1240, Costa Rica; Moín Formation
9. *Attiliosa philippiana* (Dall) (X 3) 94
FSBC I 11242; height 14.4 mm, diameter 8 mm.
Locality: About 35 miles [57 km] north of Cabo Catoche, Mexico, in 20 fathoms [37 meters]; Recent.
10, 11. *Attiliosa* species (X 3) 95
10. USNM 860299; height 13.9 mm, diameter 8 mm.
11. USNM 860298; height 14.3 mm, diameter 9.2 mm.
(Specimen in fig. 11 not whitened to show color pattern)
Locality of both: Samana, Dominican Republic, in 3 meters; Recent.

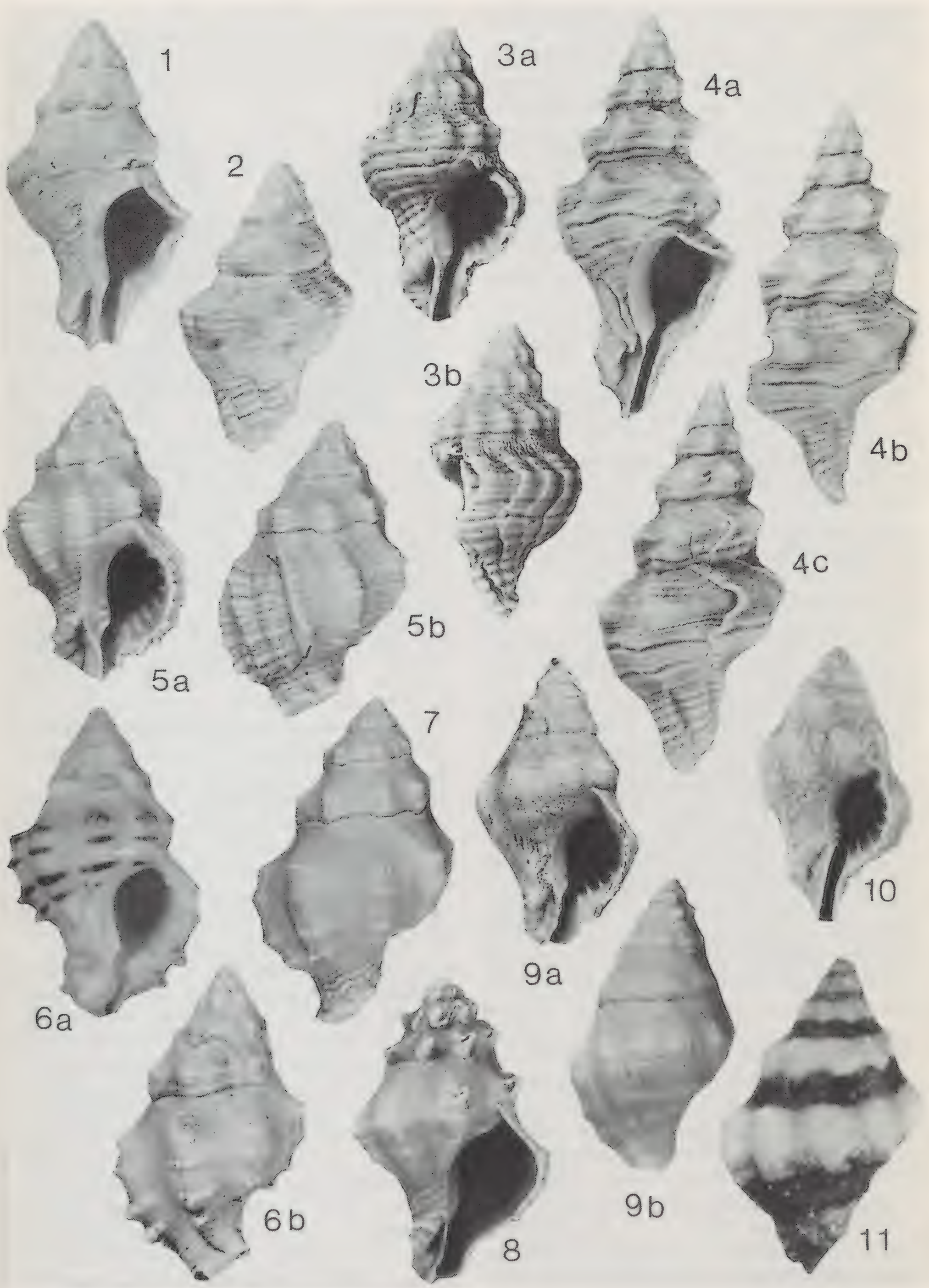

PLATE 20

expected if phylogenetically close to *Calotrophon*.

The form that oocurs at Sarasota (TU 1000) originally was figured by Petuch (1988, pl. 12, figs. 13, 14) as *A. floridana* but subsequently was described as a new species, *A. sarasotaensis* (Petuch, 1991, p. 27, pl. 4, figs. 10, 11). At that time, the specimen figured in 1988 as 18 mm in height, from Sarasota, was refigured as 24 mm in height, and from the Caloosahatchee Formation. It is *A. sarasotaensis* and is presumably from Sarasota.

ACANTHOLABIA SARASOTAENSIS Petuch

Plate 20, figure 4

Acantholabia floridana Olsson and Harbison. PETUCH, 1988, Neogene Hist. Trop. Amer. Moll., p. 51, pl. 12, figs. 13, 14; PETUCH, 1991, W.H. Dall Paleont. Resh. Center, Spec. Publ. 1, p. 28, pl. 4, fig. 12 (not of Olsson and Harbison).

Acantholabia sarasotaensis PETUCH, 1991, W.H. Dall Paleont. Resh. Center, Spec. Publ. 1, p. 27, pl. 4, figs. 10, 11.

Holotype: CM 35638; height 30.9 mm, diameter 15 mm.

Type locality: "Pinecrest Beds" (= Fruitville Formation); APAC quarry, Sarasota, Sarasota County, Florida (= TU 1000).

Occurrence: Fruitville Formation (= "Pinecrest Beds), Florida.

Figured specimen: CM 35638 (holotype).

Discussion: The members of the genus *Acantholabia* from the APAC quarry at Sarasota (TU 1000; seven specimens in our collection) are consistently different from the type material, in the higher spire and the more angulate shoulder. This morphotype is constant and, though the genus may be variable, this represents a second valid species in the group.

Genus ATTILIOSA Emerson, 1968

Attiliosa EMERSON, 1968, Veliger, v. 10, no. 4, p. 380.

Type species: *Coralliophila incompta* Berry, 1960 (= *Peristernia nodulosa* A. Adams, 1855), by original designation.

Discussion: In my original treatment of *Attiliosa* (Vokes, 1976b, p. 111), I included the Dominican Republic species *"Muricidea" striata* Gabb, 1873, as the earliest known species of the group. Subsequently, *M. striata* was transferred to the muricopsine genus *Acanthotrophon* (see Vokes, 1980) and the material I included in the species split into two taxa: *A. striata* and *A. striatoides* Vokes, 1980 (both will be covered in the next part of the series).

The oldest American representative of the genus, however, is still from the Dominican Republic, in the Cercado and the Gurabo formations, which are Late Miocene and Early Pliocene in age, respectively. Thus, the age of the earliest representative (Vokes, 1976b, p. 102) remains correct, only the name of the species has changed.

The American species is not the oldest member of the genus as there is an unnamed form in the Stampian beds of France (figured in Vokes, 1989b, pl. 6, fig. 11), which is so similar that if it were found together with *Attiliosa aldridgei* it probably would be considered conspecific. In addition, there are other Miocene species in France and Italy, which are presumed to be ancestral to the Indo-Pacific forms assigned to the genus by Vokes and D'Attilio (1982) .

The genus *Attiliosa* is comprised of but a few species, each of which has an extraordinarily complicated taxonomic history. Collectively the Recent species assigned to the group have been referred to *Murex, Muricidea, Muricopsis, Peristernia, Coralliophila, Vasum,* and *Latiaxis*. Vokes and D'Attilio (1982) reviewed the genus and recognized three Indo-Pacific species. In the New World there are three species (one not yet named) in the western Atlantic, plus the eastern Pacific type of the genus. Only *A. aldridgei* occurs in the fossil record of the western Atlantic.

Another fossil species from the Pliocene of Florida (= locality TU 1493) has been named *Attiliosa viaavensis* by Petuch (1986, p. 402, pl. 4, figs. 14, 15). There is little resemblance between the unique holotype (figured here, text figure 10) and the other species of *Attiliosa*. Indeed, if anything, it might be a *Calotrophon*. But the complete lack of varicial break, even on the siphonal canal, indicates to me that the species should not be referred to the Muricidae. The specimen is worn, especially on the early whorls, but William G. Lyons, of the Florida Dept. of Natural Resources, suggests (written comm., November, 1991) that the shell may be a species of *Latirus*.

Text-figure 10. *"Attiliosa" viaavensis* Petuch; MCZ 29222 (holotype); height 15.4 mm, diameter 7.5 mm; locality, Bird Road, Miami, Dade County, Florida.

ATTILIOSA ALDRIDGEI (Nowell-Usticke)
Plate 20, figures 5-8

Muricopsis philippiana (Dall). HUMFREY, Sea Shells of the West Indies, p. 138, pl. 16, fig. 3 (not of Dall).

Muricopsis pudicus (Reeve). HUMFREY, Sea Shells of the West Indies, p. 138, pl. 16, fig. 7 (not of Reeve).

Attiliosa aldridgei (Nowell-Usticke). VOKES, 1976, Tulane Stud. Geol. Paleont., v. 12, no. 3, p. 124, pl. 8, figs. 9 (paratype)-11; RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 25, pl. 28, fig. 5 (paratype); RADWIN and D'ATTILIO, 1978, Tulane Stud. Geol. Paleont., v. 14, no. 3, p. 132, text-fig. 4 (radula); VOKES and D'ATTILIO, 1982, Veliger, v. 25, no. 1, p. 69, figs. 6-9; VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 62, pl. 6, figs. 9, 10.

Synonym:

Muricopsis poeyi SARASUA and ESPINOSA, 1979, Poeyana, no. 193, p. 2, text-fig. 1; VOKES and D'ATTILIO, 1982, Veliger, v. 25, no. 1, p. 67, fig. 10 (holotype).

Holotype: AMNH 189620; height 29.4 mm, diameter 20 mm.

Type locality: Rat Island, Antigua, British West Indies.

Occurrence: Cercado and Gurabo formations, Dominican Republic; Caloosahatchee and Bermont formations, Florida; Moín Formation, Costa Rica. Recent, from Jamaica to Lesser Antilles, Bahama Islands, Yucatan to Panama.

Figured specimens: Fig. 5, USNM 869515; height 19.1 mm, diameter 12.8 mm; locality TU R-369. Fig. 6, Sunderland Coll.; height 29.7 mm, diameter 18.3 mm; locality, Bimini, B.W.I., in 6-9 meters. Fig. 7, USNM 462692; height 31.5 mm, diameter 20.1 mm; locality TU 1215. Fig. 8, USNM 323924; height 10.8 mm, diameter 6.9 mm; locality TU 1240. Additional occurrences: TU 283, 727, 1422, R-99, R-109, R-303.

Discussion: When I originally treated this misunderstood species (Vokes, 1976b, p. 124) it was known only from the Recent fauna, although widely distributed in the western Atlantic from the Bahamas to Panama. Since that time, we have has discovered numerous examples in the fossil record of the Dominican Republic [a total of 13 specimens from two coral-reef localities in the the Cercado (TU 1422) and Gurabo (TU 1215) formations, respectively]. In addition, juvenile examples were recognized in the Caloosahatchee (TU 283) and Bermont (TU 727) formations of southern Florida.

Because living specimens are invariably covered with a thick coating of calcareous algae, the fossil specimens commonly give a better idea of the appearance of the shell than do "cleaned" examples of Recent material. This has caused problems with identification. For example, in Jamaica, Humfrey (1975, p. 138, pl. 16, figs. 3, 7) figured an adult and a juvenile as two different species, neither identified as *A. aldridgei*. In the collection of Kevan and Linda Sunderland, Sunrise, Florida, there are numerous examples of the spinose juvenile shells from 12 to 25 meters depth on the reefs in the Bay Islands, which show the small hooked spines similar to those in the fossil specimen figured here (pl. 20, fig. 8). In the same collection is one very large example from Bimini (pl. 20, fig. 6), similar to Humfrey's adult specimen of *"Muricopsis philippiana"*; comparison with a comparably-sized example from the Gurabo Formation (pl. 20, fig. 7) shows them to be conspecific.

The two examples figured by Humfrey were referred respectively to *Muricopsis philippiana* (Dall) and *Muricopsis pudicus* (Reeve). The first of these taxa is another species of *Attiliosa* treated below and may

be distinguished from *A. aldridgei* by its more slender, non-spinose shell. The second is a species that was mistakenly described as being from the "Island of St. Domingo," perhaps the cause of Humfrey's confusion, for there is certainly little more than a familial similarity between the two. The type of *Murex pudicus* Reeve, 1845, has been figured by Kaicher (1980, no. 2504) and it is a West African species of *Hexaplex*.

Because of the relative obscurity of the original publication (Nowell-Usticke, 1969), where the species was named *Vasum aldridgei*, and the revised edition of the same (Nowell-Usticke, 1971), where the genus was changed to *Attiliosa*, the same species was also named *Muricopsis poeyi* by Sarasua and Espinosa in 1979. Comparison of a photograph of the holotype specimen provided by Dra. Sarasua and republished in Vokes and D'Attilio (1982, fig. 10) shows it to be identical to the Gurabo example figured at the same time (*ibid.*, fig. 7).

The use of the genus *Muricopsis* by Humfrey and by Sarasua and Espinosa is a reflection of the several small denticles at the base of the columellar lip, characteristic of the genus *Attiliosa*, as well as *Acanthotrophon*, a muricopsine genus with species that have been confused with those of *Attiliosa*, for the same reason. In the work that first sorted out the differences between *Attiliosa* and *Acanthotrophon*, Radwin and D'Attilio (1978) figured the radulae of both groups, showing that they are muricine and muricopsine, respectively.

The radula of *Attiliosa* is similar to that of *Poirieria* (cf. Radwin and D'Attilio, 1976, text-fig. 57, *P. zelandica)*. As noted earlier (Vokes, 1976b, p. 104), this radular type is markedly different from that of *Calotrophon*, which is more like that of *Paziella* (Radwin and D'Attilio, 1976, text-fig. 50, "*P. pazi*," actually *P. oregonia*). This corroborates the geological evidence that *Poirieria* and *Paziella* have had separate lines of descent since the beginning of the Tertiary and that, although *Calotrophon* and *Attiliosa* are both members of the "*Paziella* clan" (*sensu* Vokes, 1971a), they are not as closely related as once thought (see Vokes, 1971b, p. 7).

ATTILIOSA PHILIPPIANA (Dall)
Plate 20, figure 9

Not *Muricopsis philippiana* (Dall). HUMFREY, 1975, Sea Shells of the West Indies, p. 138, pl. 16, fig. 3 [= *Attiliosa aldridgei*].

Attiliosa philippiana (Dall). VOKES, 1976, Tulane Stud. Geol. Paleont., v. 12, no. 3, p. 120, pl. 8, figs. 12 (lectotype)-14; RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 26 (in part); RADWIN and D'ATTILIO, 1978, Tulane Stud. Geol. Paleont., v. 14, no. 3, p. 132, text-figs 6, 6a (radula); VOKES and D'ATTILIO, 1982, Veliger, v. 25, no. 1, p. 69; VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 212, pl. 1, fig. 22.

Not *Attiliosa philippiana* (Dall). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 26 (in part), pl. 3, fig. 10; KAICHER, 1980, Card Catalogue of World Wide Shells, Pack no. 25, Muricidae, Part V, fig. 2574 [= *Acanthotrophon striatoides* Vokes].

Lectotype: USNM 93337 (designated by Vokes, 1976b, p. 122); height 14.9 mm, diameter 8.8 mm.

Type locality: U.S. Fish Commission Station 2362, off Cabo Catoche, Quintana Roo, Mexico, in 25 fathoms [46 meters].

Occurrence: Recent only, southern Florida and northern Yucatan.

Figured specimen: FSBC I 11242; height 14.4 mm, diameter 8 mm; locality about 35 miles [57 km] north of Cabo Catoche, Mexico, in 20 fathoms [37 meters].

Discussion: The confusion of this species with the superficially similar *Acanthotrophon striatoides*, Vokes, 1980, began with Dall, who included two specimens in the type lot of the species he named *Muricidea philippiana*. One of these (USNM 93337), figured by Dall (1902, pl. 29, fig. 5) and subsequently selected as the lectotype (Vokes, 1976b, p. 122), is referable to the genus *Attiliosa*. But the second (USNM 34642; figured by M. Smith, 1953, pl. 20, fig. 20, as *Coralliophila philippiana*) is a specimen of *Acanthotrophon striatoides*. It is the latter that was figured as the lectotype of *philippiana* by Radwin and D'Attilio (1976, pl. 3, fig. 10) although the USNM number and locality (*ibid.*, p. 255), as well as the dimensions cited ("ca. 15 mm in length", p. 26), are all for USNM 93337, the real lectotype.

My reason for choosing USNM 93337 as lectotype is that it was the illustrated specimen and the locality given by Dall (1889, p.

213 – Station 2362) was for that specimen. However, the original description is clearly a composite of the two forms, and the dimensions cited are those of the *A. striatoides* specimen. Either one might have been selected with equal validity. Radwin and D'Attilio's slightly later designation (December, 1976 *vs.* September, 1976) of the specimen numbered USNM 93337 agrees with my action, in spite of their figuring the wrong shell.

ATTILIOSA species
Plate 20, figures 10, 11

Figured specimens: Fig. 10, USNM 860299; height 13.9 mm, diameter 8 mm. Fig. 11, USNM 860298; height 14.3 mm, diameter 9.2 mm; locality of both, Samana, Dominican Republic, in 3 meters.

Discussion: The third species of *Attiliosa* recognized in the western Atlantic, this distinctive form is readily distinguishable by the brown and white striped color pattern (pl. 20, fig. 11); although this is normally hidden beneath a thick calcareous covering (pl. 20, fig. 10), as is typical of the genus. The description of this new species is being published by Petuch and is included here only to complete the survey of the genus in the western Atlantic. At present it is known only from the type locality in the Dominican Republic.

POSTSCRIPT

In the previous portion of this Addendum (Vokes, 1990, p. 6) I once again raised the question as to the correct locality for the seemingly Indo-Pacific species described as *Murex surinamensis* Okutani, 1982. I felt certain the species did not come from the western Atlantic but had no better suggestion to offer. Since that time work by two different sets of authors (Emerson and Sage, 1991; Bouchet and Bail, 1991) has shown that apparently the locality is the Saya de Malha Bank, to the east of Madagascar. This location is arrived at by switching not only West for East longitude, but also North for South Latitude (a complication I had not even contemplated).

These two papers resulted in a note by Okutani himself (1991) explaining how the mix-up occurred and a correction for the type locality of several species, including *Murex surinamensis*, which correctly reads: 10°46′ South, 61°32′ East, in 94 meters.

This correction leaves us with the very suspect *Murex maculatus* Verrill, 1950, as the only possible species of *Murex* s.s. in the western Atlantic. The holotype of *M. maculatus* still has not been located, but I believe that we may safely state that there are *no* species of *Murex* s.s. in the western Atlantic.

V. LOCALITY DATA

The following are Tulane University fossil locality numbers:

60. Jackson Bluff Fm., borrow pits at Jackson Bluff, Ochlockonee River (NW 1/4 Sec. 21, T1S, R4W), Leon Co., Florida.
61. Stone City Beds, type locality, Stone City Bluff on Brazos River, at crossing of bridge of Texas Highway 21, Burleson Co., Texas.
66. Byram Marl, type locality, west bank of Pearl River, at Byram, Hinds Co., Mississippi.
68. Caloosahatchee Fm., North St. Petersburg, 70th Ave. at 9th St. N., Pinellas Co., Florida.
69. Shoal River Fm., type locality, Shell Bluff, Shoal River (NW 1/4 Sec. 4, T3N, R21W), about 3 1/2 miles north of Mossyhead, Walton Co., Florida.
69A. Shoal River Fm., first ravine upstream from Shell Bluff, Shoal River (NW 1/4 Sec. 4, T3N, R21W), about 3 1/2 miles north of Mossyhead, Walton Co., Florida.
73. Jackson Bluff Fm., "Dripping Springs," Four Mile Creek, about 1000 feet upstream from bridge of Florida Highway 73 (NE 1/4 Sec. 36, T1N, R10W), Calhoun Co., Florida.
79. Caloosahatchee and Bermont fms. mixed, spoil banks north and south side of Caloosahatchee River, at Ortona Lock (Sec. 27, T42S, R30E), Glades Co., Florida.
85. Wautubbee Fm., roadcuts on county road, 4 miles northeast of Rose Hill, Jasper Co., Mississippi.
91. Oak Grove Sand, type locality, west bank of Yellow River, about 100 yards below bridge at Oak Grove (NE 1/4 Sec. 20, T5N, R23W), Okaloosa Co., Florida.
99. Moodys Branch Fm., Montgomery Landing (also known as Creola Bluff), west bank of Red River (Sec. 20, T8N, R5W), Grant Parish, Louisiana.
201. Bermont Fm., spoil banks at pit just south of Belle Glade (at Belle Glade Camp), Palm Beach Co., Florida.

226. Red Bluff Fm., west bank Chickasawhay River, approximately 1 mile southwest of Hiwannee (SW 1/4 Sec. 28, T10N, R7W), Wayne Co., Mississippi.
283. Caloosahatchee and Bermont fms. mixed, spoil banks on cross-canal 1.3 miles southwest of Port Charlotte Railroad Station (formerly Murdock), on south side of Florida Highway 771 and Seaboard Air Line R. R. line (Sec. 12, T40S, R21E), Charlotte Co., Florida.
457. Chipola Fm., west bank of Chipola River, about 1/2 mile below Tenmile Creek (SW 1/4 Sec. 17, T1N, R9W), Calhoun Co., Florida (= USGS 2213, 2564, and 3419, "one mile below Bailey's Ferry").
458. Chipola Fm., east bank of Chipola River, above Farley Creek (SW 1/4 Sec. 20, T1N, R9W), Calhoun Co., Florida.
459. Chipola Fm., east bank of Chipola River, steep bank about 1500 feet above the mouth of Taylor Lake Branch (NW 1/4 Sec. 29, T1N, R9W), Calhoun Co., Florida.
519. Caloosahatchee Fm., Harney Pond Canal spoil banks, at Florida Highway 78, northwest side of Lake Okeechobee (NW 1/4 Sec. 18, T40S, R33E), Glades Co., Florida.
539A. Bermont Fm., Shell Creek (upper beds), about eight miles east of Cleveland (Sec. 30, T40S, R25E), Charlotte Co., Florida.
539B. Caloosahatchee Fm., Shell Creek (lower beds), about eight miles east of Cleveland (Sec. 30, T40S, R52E), Charlotte Co., Florida.
546. Chipola Fm., Tenmile Creek, about 1 3/4 miles west of Chipola River (NE 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida (= USGS 2212, "one mile west of Bailey's Ferry").
547. Chipola Fm., west bank of Chipola River, about 2000 feet above Fourmile Creek (SW 1/4 Sec. 29, T1N, R9W), Calhoun Co., Florida.
549. Chipola Fm., east bank of Chipola River, about 1/4 mile below Fourmile Creek (NE 1/4 Sec. 32, T1N, R9W), Calhoun Co., Florida.
554. Chipola Fm., east bank of Chipola River at power line crossing (SW 1/4 Sec. 17, T1N, R9W), Calhoun Co., Florida.
555. Chipola Fm., east bank of Chipola River, about 1000 feet above Fourmile Creek (SW 1/4 Sec. 29, T1N, R9W), Calhoun Co., Florida.
558. Waccamaw Fm., borrow pits at north end of Crescent Beach Airport, Crescent Beach, Horry Co., South Carolina.
562. Silverdale Beds (Belgrade Fm.), Onslow County marl pit on south side of Webb Creek, near Silverdale, Onslow Co., North Carolina.
638. Agueguexquite Fm., roadcut, pipeline cut, and quarry on [old] Mexico Highway 180, 22.5 km east of junction with side road into Coatzacoalcos, Veracruz, Mexico.
655. Chipola Fm., Tenmile Creek, about 0.1 mile downstream from bridge of Florida Highway 73 (NW 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida.
705. Bowden Fm., type locality, Bowden, east of Port Morant, Parish of St. Thomas, Jamaica.
727. Bermont Fm., borrow pits 2.2 miles east of U.S. Highway 27, 15 miles south of South Bay, Palm Beach Co., Florida.
728. Pinecrest Beds (Fruitville Fm.), spoil banks on west side of Kissimmee Canal and east side of Kissimmee River, just across from U.S. Corps of Engineers Structure 65-D (Sec. 33, T36S, R33E), Okeechobee Co., Florida.
729. Pinecrest Beds (Fruitville Fm.), spoil banks on west side of Kissimmee Canal and east side of Kissimmee River, approximately 1/2 mile south of U.S. Corps of Engineers Structure 65-D (S 1/2 Sec. 33, T36S, R33E), Okeechobee Co., Florida.
730. Pinecrest Beds (Fruitville Fm.), embankment of Seaboard Airline Railroad, just west of Kissimmee River (NW 1/4 Sec. 20, T36S, R33E), Highlands Co., Florida.
735. Matthews Landing Marl, roadcut on Wilcox Co. Highway 162 (formerly Alabama Highway 10), 10 miles northeast of railroad station at Kimbrough, Wilcox Co., Alabama.
757. Gatun Fm., roadcut on south side of Boyd-Roosevelt Highway at junction of road to "Refinería Panamá, S.A.," just east of Cativá, Prov. of Colón, Panama.
759. Bermont Fm., spoil banks north side of Caloosahatchee River, two miles west of Ortona Lock (NE 1/4 Sec. 29, T42S, R30E), Glades Co., Florida.
797. Pinecrest Beds, material exposed during construction of "Alligator Alley," 13.3 miles east of Florida Highway 29 (T49S, R32E), Collier Co., Florida.
803. Bermont Fm., spoil banks south side of Caloosahatchee River, two miles west of Ortona Lock (NE 1/4 Sec. 29, T42S, R 30E), Glades Co., Florida.
819. Chipola Fm., Farley Creek, 0.2 mile west of bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.
820. Chipola Fm., Farley Creek, at bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.
823. Chipola Fm., Farley Creek, south bank about 2000 feet east of bridge of Florida Highway 275 (SE 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.

825. Chipola Fm., Farley Creek at abandoned mill about 1/4 mile west of bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.
826. Chipola Fm., Farley Creek, about 0.1 mile west of abandoned mill, which is 1/4 mile west of bridge of Florida Highway 275 (on section line between Sec. 20 & 21, T1N, R9W), Calhoun Co., Florida.
830. Chipola Fm., Tenmile Creek, at power line crossing about one mile west of Chipola River (SE 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida.
866. Silverdale Beds (Belgrade Fm.), marl pit on north side of Webb creek and east side of unnumbered county highway, Silverdale, Onslow Co., North Carolina.
932. Pinecrest Beds (Fruitville Fm.), east side of Kissimmee Canal and 1/2 mile south of Seaboard Airline Railroad, south of Fort Basinger (SE 1/4 Sec. 20, R36S, R33E), Okeechobee Co., Florida.
949. Chipola Fm., Chipola River, west bank about 0.1 mile below power line crossing (SW 1/4 Sec. 17, T1N, R9W), Calhoun Co., Florida.
950. Chipola Fm., Chipola River, west bank about 2000 feet above Farley Creek (SW 1/4 Sec. 20, T1N, R9W), Calhoun Co., Florida.
951. Chipola Fm., Tenmile Creek, about 1 1/4 miles west of Chipola River (SE 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida.
954. Moín Fm., hill cut immediately behind Standard Fruit Co. box factory, just west of cemetery at Pueblo Nuevo, about 2 km west of Puerto Limón, Costa Rica.
958. Gatun Fm., hillslope on east side of road from Boyd-Roosevelt Highway to "Refinería Panamá, S. A.," about 1/2 km north of junction, just east of Cativá, Prov. of Colón, Panama.
993. Weches Fm., roadcut and glade on north side of Texas Highway 21, 3 1/2 miles west of junction with Texas FM 95 at Chireno, Nacogdoches Co., Texas.
998. Chipola Fm., Tenmile Creek, about 1 1/4 miles west of Chipola River (SE 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida.
999. Chipola Fm., Farley Creek, about 300 yards downstream from bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.
1000. Pinecrest Beds (Fruitville Fm.), borrow pit at east end of 17th street (T36S, R19E), about 8 miles east of U.S. Highway 301 at Sarasota, Sarasota Co., Florida.
1020. Chipola Fm., small tributary (not shown on USGS topographic map) on east bank of Chipola River about 1/2 mile below power line crossing (NE 1/4 Sec. 20, T1N, R9W), Calhoun Co., Florida.
1021. Chipola Fm., Tenmile Creek, north bank, about 2200 feet east of bridge on Florida Highway 73 (NW 1/4 Sec. 12, T1N R9W), Calhoun Co., Florida.
1025. Concepcion Inferior Fm., first road cut on east side of old road from Nueva Teapa to Ixhuatlan, 0.8 km south of junction with highway to Coatzacoalcos (old Mexico Highway 180), Veracruz, Mexico [new highway 180 parallels this road slightly to the east].
1046. Agueguexquite Fm., roadcuts on both sides of [old] Mexico Highway 180, 12 km east of junction with side road into Coatzacoalcos, Veracruz, Mexico.
1048. Chipola Fm., Farley Creek, south bank, about 0.8 miles east of bridge of Florida Highway 275 (NE 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.
1050. Chipola Fm., west bank of Chipola River immediately below power line crossing, and directly across river from loc. TU 554 (SW 1/4 Sec. 17, T1N, R9W), Calhoun Co., Florida.
1097. Chipola Fm., Tenmile Creek, south bank of 1972 cut-off meander, 500 yards east of Florida Highway 73 (NW 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida.
1098. Chipola Fm., Tenmile Creek, south bank just below power line crossing (SE 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida.
1175. Tamiami Fm., spoil banks along canals south of Florida Highway 858, 2 miles east of junction with Florida Highway 846 (SE 1/4 Sec. 24, T48S, R27E), east of Naples and south of Immokalee, Collier Co., Florida.
1177. Tamiami Fm., Mule Pen Quarry, north side of Florida Highway 846, 9.1 miles east of U.S. 41 at Naples Park (SE 1/4 Sec. 24, T48S, R26E), Collier Co., Florida.
1196. Chipola Fm., Farley Creek, north bank about 0.8 mile east of bridge on Florida Highway 275 (NE 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.
1203. Byram Fm., quarry of Mississippi Valley Portland Cement Co., on east side of Mississippi Highway 3, 2.8 miles north of junction with U.S. Highway 61 at Redwood, Warren Co., Mississippi.
1208. Mao Adentro Limestone, roadcut, both sides of highway from Mao to Los Quemados, at ridge 4 km east of Los Quemados, Dominican Republic.
1210. Gurabo Fm., Río Gurabo, east bank, first bluff downstream from ford on Los Quemados-Sabaneta road, Dominican Republic.
1211. Gurabo Fm., Río Gurabo, west bank, second bluff below the ford on Los

Quemados-Sabaneta road, Dominican Republic.

1212. Gurabo Fm., Río Gurabo, east bank, third bluff below the ford on Los Quemados-Sabaneta road, Dominican Republic.

1215. Gurabo Fm., Río Gurabo, bluffs on both sides, from the ford on Los Quemados-Sabaneta road upstream to approximately 1 km above the ford, Dominican Republic.

1219. Gurabo Fm., Río Amina, bluffs on east side of river immediately upstream from ford that is 2 km west of Potrero and about 3 km downstream from "La Represa," Dominican Republic.

1225. Gurabo Fm., banks of Arroyo La Sabrima, west side of Río Mao, upstream from Mao Adentro and downstream from Cercado de Mao, about 11 km by (winding) road or 8 km airline, south of Mao, Dominican Republic.

1227. Gurabo Fm., Arroyo Zalaya, which crosses road to Jánico from Santiago de los Caballeros, 11 km south of bridge over Río Yaque del Norte at Santiago, Dominican Republic.

1227A. Gurabo Fm., Arroyo Zalaya, turbidity flow lens (ca. 30" long, 6" thick) about two feet above base of outcrop at point approximately 75 feet downstream from highway bridge, Dominican Republic.

1231. Gurabo Fm., Río Gurabo, float found in river gravel above and below ford on Los Quemados-Sabaneta road, Dominican Republic.

1239. Moín Fm., hill cut above Standard Fruit Co. box factory at Pueblo Nuevo (same as TU 954 but stratigraphically about 15 meters higher – above coral horizon), Puerto Limón, Costa Rica.

1240. Moín Fm., Barrio Los Corales, top of hill at end of road that passes Standard Fruit Co. box factory (see TU 954), 1.8 km north of main highway at Pueblo Nuevo, which is 2 km west of Puerto Limón, Costa Rica.

1250. Gurabo Fm., Río Verde, south bank, just above the ford at the crossing of a side road that connects Duarte Highway and La Vega-Moca Highway, about 10 km north of La Vega, Dominican Republic.

1251. Gurabo Fm., Río Verde, north bank, high bluff about 0.5 km down from the ford at the crossing of a side road that connects Duarte Highway and La Vega-Moca Highway, about 10 km north of La Vega, Dominican Republic.

1258. Weches Fm., west side of spillway and dam of Lake Nacagdoches, on north side of Texas Highway FM 225, 10 miles west of Bypass 224, west of Nacogdoches, Nacogdoches Co., Texas.

1262. Weches Fm., roadcut on south side of Texas Highway 21, 3.8 miles west of junction with FM 95, at Chireno, Nacogdoches, Texas.

1269. Cantaure Fm., series of arroyos about 500 meters south of "Casa Cantaure" [which is literally one house and which is about 400 meters south of older, now abandoned, house that was the "Casa Cantaure" of Jung, 1965, and others], 14 km (by road) west of Pueblo Nuevo, Paraguaná Peninsula, Venezuela.

1277. Gurabo Fm., Río Gurabo, both sides, upstream from the horsetrail to 0.5 km above the trail, or approximately 2 km (airline) to 2.5 km above the bridge on Los Quemados-Sabaneta road, Dominican Republic.

1282. Cercado Fm., tributary of the Río Cana to the east, about 1 km above the bridge at Caimito on Los Quemados-Sabaneta road, Dominican Republic.

1288. Red Bluff Fm., type locality, east bank Chickasawhay River, about 1 1/2 miles south of Shubuta (NE 1/4 Sec. 16, T10N, R7W), Wayne Co., Mississippi.

1289. Red Bluff Fm., east bank Chickasawhay River, about 3/4 mile south of Hiwannee (SW 1/4 Sec. 28, T10N, R7W), Wayne Co., Mississippi.

1290. Red Bluff Fm., "Carson Sand Creek," at crossing of county road 1 1/2 miles east of Hiwannee (SE 1/4 Sec. 26, T10N, R7W) [possibly Aldrich's Carson Creek loc.], Wayne Co., Mississippi.

1292. Gurabo Fm., Río Mao, west bank, bluffs about 1.5 to 2 km upstream from Mao Adentro, or about 9 km (by road) south of Mao, Dominican Republic.

1296. Gurabo Fm., Río Gurabo, both sides, from about 0.5 km above the horsetrail to approximately 1 km above the trail, or about 2.5 to 3 km (airline) above the ford on Los Quemados-Sabaneta road, Dominican Republic.

1307. Moín Fm., hill top approximately halfway between Puerto Limon and Barrio Los Corales and about 0.5 km north of highway at Pueblo Nuevo, Costa Rica.

1318. Concepcion Inferior Fm., hillcut on pipeline just to northeast of Campo El Chapo, on old road to Ixhuatlan, 4 km south of old road to Coatzacoalos at Nueva Teapa, Veracruz [new highway 180 parallels this road slightly to the east].

1321. Concepcion Inferior Fm., "Kilometer 70" (of Toula, 1911), which is K 70 on Trans-Isthmus railroad south of Coatzacoalcos, 5 km north of Almagres, Veracruz, Mexico.

1353. Gurabo Fm., Arroyo Puñal, outcrops on

south side, above the crossing of the trail from Guayubal to Yabanal, which intersects the paved highway 1.5 km south of Guayubal (*ca.* 12 km airline southeast of Santiago de los Caballeros), Dominican Republic.

1354. Gurabo Fm., Cañada de Zamba, a tributary on the west side of the Río Cana, approximatley 2.5 km east of the village of Zamba, which is 7 km north of Cruz de Santiago (Santiago Rodrigez), on road to Guayubin; or 4.5 km (airline) below the ford at Caimito, Dominican Republic.

1357. Gurabo Fm., Río Yaque del Norte, bluff on west side, just above new (1980) water plant at south edge of Bella Vista, 3 km (by road) south of bridge at Santiago de los Caballeros, Dominican Republic.

1381. Gurabo Fm., Arroyo Babosico, bluffs just up from confluence with Río Yaque del Norte at La Barranca, approximately 8 km upstream from Santiago de los Caballeros, Dominican Republic.

1397. Esmeraldas Beds, Quebrada Camarones, cut-bank on east side of canyon, which is at east edge of village of Camarones, 20 km (by road) east of bridge over Río Esmeraldas, at Esmeraldas, or approximatley 10 km east of mouth of Río Esmeraldas, Prov. of Esmeraldas, Ecuador.

1412. Gurabo Fm., Río Guanajuma, which is a tributary of Río Amina from the west, bluff on south side just upstream from trail at Higuerito Penuelas, which goes to the river approximately 2.5 km upstream from the confluence with Río Amina; or about 1 km above the ford on the road to Potrero, Dominican Republic.

1422. Cercado Fm., Arroyo Bellaco (or Beyaco on topographic maps), which is a tributary of Río Cana from the east, coral reef that is exposed for approximately 1 km below the ford at Las Caobas Adentro, 1 km southwest of Las Caobas, Dominican Republic.

1429. Gatun Fm., construction site, one km southeast of Boyd-Roosevelt Highway, just south of Coco Solo Hospital, Prov. of Colón, Panama.

1431. Gatun Fm., hilltop construction site, 0.5 km northwest of intersection of Boyd-Roosevelt Highway and road to Puerto Pilon, at Sabanita, Prov. of Colón, Panama.

1432. Gatun Fm., north side Boyd-Roosevelt Highway, clearing behind Residential Martin Luther King (formerly Palo Quemado) approximately 1.5 km east of junction of road to Refinería Panamá, S.A., at Cativá, Prov. of Colón, Panama.

1433. Gatun Fm., north side Boyd-Roosevelt Highway, clearing behind Urbanization San Martin, approximately 0.5 km east of junction of road to Refinería Panamá, S.A., at Cativá, Prov. of Colón, Panama.

1448. Gurabo Fm., Río Yaque del Norte, west side, bluffs extending for approximately 1 km upstream from the village of La Barranca, Dominican Republic.

1449. Gurabo Fm., Río Yaque del Norte, west bank, large gravity flows exposed along road that leads down to river at village of La Barranca, Dominican Republic.

1452. Gurabo Fm., Arroyo Zalaya, bluffs on both sides, from crossing of the trail at village of Zalaya upstream for approximately 1 km, Dominican Republic.

1489. Moín Fm., Barrio Los Corales no. 3, *ca.* 0.4 km north of TU 1240, Puerto Limón, Costa Rica.

1491. "Pinecrest Beds," North Ft. Meyers, pits open during construction of Cape Coral, northwest of intersection of U.S. Highway 41 and Florida Highway 78, Lee Co., Florida.

1492. Caloosahatchee Fm., approximately 4 miles southeast of Clewiston (1 mile east and 3 miles south on road to U. S. Sugar Co. Mill), Palm Beach Co., Florida.

1493. "Pinecrest Beds," Arvita Pit, on Bird Road (= W. 40th St.), approximately 5 miles west of Florida Turnpike, on west side of Coral Gables, Dade Co., Florida.

1512. Caloosahatchee and Bermont fms. mixed, DeSoto Mining Company, pits 2 miles east of Florida Highway 31, about 12 miles south of Arcadia (T39S, R25E), DeSoto Co., Florida.

1514. Concepcion Inferior Fm., roadcuts 1.5 km south of intersection of old Mexico Highway 180 (now side road into Coatzacoalcos) on new bypass, which is 15 km east of old bridge at Coatzacoalcos, Veracruz, Mexico.

1515. Concepcion Inferior Fm., roadcuts 0.5 km south of intersection of old Mexico Highway 180 (now side road into Coatzacoalcos) on new bypass, which is 15 km east of old bridge at Coatzacoalcos, Veracruz, Mexico.

1527. Weches Fm., roadcut on west side of U.S. Highway 259, 3.2 miles north of overpass over U.S. Highway 59, north of Nacogdoches, Nacogdoches Co., Texas.

1529. Weches Fm., "Old Donahue Place", beds just below waterfall, south of house; 2 miles west of Texas Highway FM 3, at gate which is 7.1 miles north of Normangee, Leon Co., Texas.

The following are Tulane University Recent locality numbers:

R-9. Dredged in 5 to 9 meters off Longboat Key, Sarasoto, Sarasota Co., Florida.
R-42. Anna Maria Key, off Sarasota, Florida; dredged in approximately 46 meters, by James Moore, Bradenton, Florida.
R-44. Isla Mujares, open ocean side, Quintana Roo, Mexico.
R-98. *Anton Bruun* Cruise 10, dredged in 40 meters northwest of Holandes Cay, and east-northeast of Cape San Blas (9°37′N, 78°50.3′W), Panama.
R-99. *Anton Bruun* Cruise 10, dredged in 31 meters, off northeastern Yucatan Peninsula (21°41′N, 86°34′W), Mexico.
R-109. Bahia de las Minas, Isla Payardi, Prov. of Colón, Panama (7000 YBP).
R-181. Piña, beach on Caribbean coast due west of Gatun, Panama.
R-303. Punta Mosquito, about 8 km east of the village of Holbox, Isla Holbox, Quintana Roo, Mexico.
R-314. Ham's Bay, rocky intertidal area, northest corner of St. Croix, U.S. Virgin Islands.
R-366. Punta Cahuita, 42 km southeast of Puerto Limón, Costa Rica.
R-369. Moín Bay, north side of Limon Peninsula; material dredged from bay for fill to make oil terminal (1976), Moín, Costa Rica.
R-503. Roatan Island, south side of Oak Ridge, Islas de la Bahia (Bay Islands), Honduras.

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VII. APPENDIX I: ALPHABETICAL LIST OF SPECIES INCLUDED IN THIS PART

The following list includes all species treated systematically, as well as certain synonyms not repeated from previous parts. Thus, this is a complete list of names for all western Atlantic species, fossil and Recent, valid or invalid, referred to the genera *Pterynotus, Poirieria, Aspella, Dermomurex, Calotrophon, Acantholabia,* and *Attiliosa.*

All species were originally named as "*Murex*" unless otherwise noted in brackets following the name. Those species names in ALL CAPS are new taxa described herein. The generic assignment that follows the name of the author is that one to which the species is referred in this paper. Those names without a generic assignment are considered synonyms of the species cited.

abyssicola Crosse, 1865. DERMOMUREX (TRIALATELLA)
actinophorus Dall, 1889. POIRIERIA s.s.
adamsii Kobelt, 1877. = *alabastrum*
alabastrum A. Adams, 1864. DERMOMUREX s.s.
alaquaensis [Muricidea] Mansfield, 1935. POIRIERIA (PANAMUREX)
aldridgei [Vasum] Nowell-Usticke, 1969. ATTILIOSA
aliculus [Pterynotus] Vokes, 1989. PTERYNOTUS s.s.
andrewsi [Calotrophon] Vokes, 1976. CALOTROPHON
angulatus Meyer, 1886. ? = *silvaticus*
angelus Aldrich, 1886. PTERYNOTUS (PTEROCHELUS)
antecessor [Dermomurex] Vokes, 1975. DERMOMUREX (TRIALATELLA)
ariomus Clench and Pérez Farfante, 1945. PTERYNOTUS (PTEROCHELUS)
ascensus [Calotrophon] Vokes, 1976. ACANTHOTROPHON
atlantis Clench and Pérez Farfante, 1945. POIRIERIA (PAZIELLA)
attenuta [Muricidea] Dall, 1890. = *ostrearum*
aurorae [Pterynotus] Garvie, 1991. PTERYNOTUS s.s.
BINGHAMAE [*Dermomurex*] Vokes. DERMOMUREX s.s.
bowdenensis [Poirieria] Vokes, 1970. POIRIERIA (PAZINOTUS)
burnsii Aldrich, 1894. PTERYNOTUS s.s.
bushae [Pterynotus] Vokes, 1970. = *phaneus*
cantrainei [Triton] Recluz, 1853. = *pauperculus*
castor [Aspella] Radwin and D'Attilio, 1976. ASPELLA
carnicolor Clench and Pérez Farfante, 1945. POIRIERIA (PANAMUREX)
clarksvillensis [Muricidea] Mansfield, 1937. POIRIERIA (PANAMUREX)
collatus Guppy, 1873. POIRIERIA (FLEXOPTERON)
conradi [Muricidea] Mansfield, 1930. CALOTROPHON
cookei [Dermomurex] Vokes, 1975. DERMOMUREX (TAKIA)
cracentis [Dermomurex] Vokes, 1989. DERMOMUREX s.s.
cretacea [Poirieria] Garvie, 1991. POIRIERIA (PAZIELLA)
cryptica [Aspella] Radwin and D'Attilio, 1976. ASPELLA
cuna [Dermomurex] Petuch, 1990. = *antecessor*
curviductus [Dermomurex] Vokes, 1975. DERMOMUREX (TAKIA)
dominicensis [Trophon] Gabb, 1873. POIRIERIA (PAZIELLA)
dubitalis [Poirieria] Vokes, 1970. = *alaquaensis*
elizabethae [Aspella] McGinty, 1940. DERMOMUREX (GRACILIMUREX)
emilyae [Calotrophon] Petuch, 1988. = *ostrearum*
engonatus [Trophon] Dall, 1892. = *alabastrum*
EUGENIAE [*Poirieria*] Vokes. POIRIERIA (PANAMUREX)
farleyensis [Dermomurex] Vokes, 1975. DERMOMUREX (TRIALATELLA)
floridana [Acantholabia] Olsson and Harbison, 1953. ACANTHOLABIA
floridana [Urosalpinx] Conrad, 1869. = *ostrearum*
fusinoides [Paziella] Gardner, 1947. POIRIERIA (PANAMUREX)
gabbi [Poirieria] Vokes, 1970. POIRIERIA (PANAMUREX)
gatunensis Brown and Pilsbry, 1911. POIRIERIA (PANAMUREX)
GIBSONSMITHI [*Poirieria*] Vokes. POIRIERIA (PANAMUREX)
gilletteorum Vokes, 1963. = *sexangulus*
glicksteini [Dermomurex] Petuch, 1987. DERMOMUREX s.s.
grandispinosa Aldrich, 1895. = *burnsii*
granulatus [Dermomurex] Vokes, 1989. DERMOMUREX s.s.
guesti [Pterynotus] Harasewych and Jensen, 1979. PTERYNOTUS s.s.
harrisi [Poirieria] Vokes, 1970. POIRIERIA (PAZIELLA)
havanensis [Pterynotus] Vokes, 1970. PTERYNOTUS s.s.
heilprini [Muricopsis] Cossmann, 1903. POIRIERIA (PANAMUREX)

helenae Verrill, 1953. ? = *ariomus*, ? = *triformis*
hoerlei [Pterynotus] Vokes, 1970. PTERYNOTUS s.s.
hutchisoni [Calotrophon?] Jung, 1969. CALOTROPHON
hystricinus Dall, 1889. POIRIERIA (?PAZINOTUS)
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laccapoia [Muricopsis] Gardner, 1947. POIRIERIA (PANAMUREX)
leali [Dermomurex] Houart, 1991. DERMOMUREX (TRIALATELLA)
libertiensis [Muricidea] Mansfield, 1930. = *conradi*
lightbourni [Pterynotus] Harasewych and Jensen, 1979. PTERYNOTUS s.s.
lychnia [Paziella] Gardner, 1947. POIRIERIA (PANAMUREX)
macneili [Poirieria] Vokes, 1970. POIRIERIA (PANAMUREX)
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matthewsensis Aldrich, 1886. PTERYNOTUS s.s.
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mexicanus [Fusus] Reeve, 1848. = *ostrearum*
mirificus [Pterynotus] Vokes, 1989. PTERYNOTUS (PURPURELLUS)
morchi [Aspella] Radwin and D'Attilio, 1976. ASPELLA
morulus Conrad, 1860. = *harrisi*
neotripterus [Pterynotus] Vokes, 1989. PTERYNOTUS s.s.
nuttingi Dall, 1896. POIRIERIA (PAZIELLA)
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oregonia Bullis, 1964. POIRIERIA (PAZIELLA)
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oxum [Dermomurex] Petuch, 1979. DERMOMUREX (TRIALATELLA)
pacei [Dermomurex] Petuch, 1988. DERMOMUREX s.s.
pauperculus C.B. Adams, 1850. DERMOMUREX s.s.
pazi Crosse, 1869. POIRIERIA (PAZIELLA)
perplexus [Cantharus] Olsson and Harbison, 1953. = *ostrearum*
PETUCHI [*Poirieria*] Vokes. POIRIERIA (PAZIELLA)
phagon [Urosalpinx] Gardner, 1947. CALOTROPHON
phaneus Dall, 1889. PTERYNOTUS s.s.
philippiana [Muricidea] Dall, 1889. ATTILIOSA
phyllopterus Lamarck, 1822. PTERYNOTUS s.s.
poeyi [Muricopsis] Sarasua and Espinosa, 1979. = *aldridgei*
PORTELLI [*Dermomurex*] Vokes. DERMOMUREX (TAKIA)
postii [Pteropurpura] Dall, 1896. PTERYNOTUS s.s.
PRAEPATAGIATUS [*Pterynotus*] Vokes. PTERYNOTUS s.s.
progne [Trophon] White, 1887. ? POIRIERIA (PAZIELLA)
propeposti [Purpura] Mansfield, 1937. PTERYNOTUS s.s.
pterynoides [Dermomurex] Vokes, 1989. DERMOMUREX (TRIALATELLA)
pygmaeus Bush, 1893. = *bushae*, = *phaneus*
radwini [Pterynotus] Harasewych and Jensen, 1979. PTERYNOTUS s.s.
recticanalis [Latirus] Weisbord, 1962. POIRIERIA (PANAMUREX)
repetiti [Pterynotus] Vokes, 1970. PTERYNOTUS (PURPURELLUS)
rubridentatus Reeve, 1846. = *phyllopterus*
rufirupicolus Dall, 1916. PTERYNOTUS s.s.
RUTSCHI [*Poirieria*] Vokes. POIRIERIA (PANAMUREX)
sabinola Palmer, 1960. PTERYNOTUS s.s.
sarasotaensis [Acantholabia] Petuch, 1991. ACANTHOLABIA
SARASUAE [*Dermomurex*] Vokes. DERMOMUREX s.s.
SARKINI [*Dermomurex*] Vokes. DERMOMUREX s.s.
senex [Aspella] Dall, 1903. ASPELLA
septima [Poirieria] Vokes, 1970. POIRIERIA (PAZIELLA)
sexangula Dall, 1915. DERMOMUREX (TAKIA)
silvaticus Palmer, 1937. POIRIERIA (PAZINOTUS)
simplex Aldrich, 1886. = *macneili*
spinulosa Heilprin, 1886. = *heilprini*
stenzeli [Pterynotus] Vokes, 1970. PTERYNOTUS s.s.
stimpsonii [Eupleura] Dall, 1889. POIRIERIA (PAZINOTUS)
susankhanae [Panamurex] Petuch, 1991. = *clarksvillensis*
tristichus Dall, 1889. = *havanensis*
varians [Aspella] Nowell-Usticke, 1969. = *alabastrum*
vaughani Maury, 1910. DERMOMUREX (TAKIA)
veatchi Palmer, 1937. = *sabinola*
velero [Poirieria] Vokes, 1970. POIRIERIA (PANAMUREX)
VENEZUELANUS [*Calotrophon*] Vokes. CALOTROPHON
viaavensis [Attiliosa] Petuch, 1986. = ? FASCIOLARIIDAE
weisbordi Palmer, 1947. PTERYNOTUS s.s.
werneri Toula, 1911. = *dominicensis*
woodsensis [Poirieria] Vokes, 1970. POIRIERIA s.s.
WORSFOLDI [*Dermomurex*] Vokes. DERMOMUREX s.s.
xenos [Pterynotus] Harasewych, 1982. PTERYNOTUS s.s.

VIII. APPENDIX II: STRATIGRAPHICAL LIST OF SPECIES INCLUDED IN THIS PART

The following list is arranged in approximately ascending stratigraphical order, with all of the species recognized as occurring in each formation.

LATE CRETACEOUS

Kemp Clay, Texas
- *Poirieria (Paziella) cretacea*

PALEOCENE

Matthews Landing Marl Member, Porters Creek Formation, Alabama
- *Pterynotus (Pterynotus) matthewsensis*
- *Poirieria (Poirieria)* species
- *Poirieria (Paziella) harrisi*

Bells Landing Marl Member, Tuscahoma Formation, Alabama
- *Pterynotus (Pterynotus) aurorae*

Maria Farhina Formation, Pernambuco, Brazil
- (?)*Poirieria (Paziella) progne*

EARLY EOCENE

Bashi Marl Member, Hatchetigbee Formation, Alabama
- *Poirieria (Poirieria) woodsensis*

MIDDLE EOCENE

Weches Formation, Texas
- *Pterynotus (Pterynotus) stenzeli*
- *Poirieria (Pazinotus) silvatica*

Stone City Beds, Texas
- *Pterynotus (Pterynotus) sabinola*
- *Poirieria (Pazinotus) silvatica*

Cook Mountain Formation, Louisiana, Texas (= Crockett Formation), and Mississippi (= Wautubbee Formation)
- *Pterynotus (Pterynotus) sabinola*
- *Poirieria (Pazinotus) silvatica*

LATE EOCENE

Moodys Branch Formation, Louisiana and Mississippi
- *Pterynotus (Pterynotus) weisbordi*
- (?)*Poirieria (Pazinotus) silvatica*

EARLY AND MIDDLE OLIGOCENE

Red Bluff Formation, Mississippi
- *Pterynotus (Pterynotus) burnsii*
- *Pterynotus (Pterochelus) angelus*
- *Dermomurex (Takia) cookei*

Mint Springs Formation, Mississippi
- *Dermomurex (Takia) cookei*

Byram Formation, Mississippi
- *Poirieria (Panamurex) macneili*

Suwannee Limestone, Florida
- *Pterynotus (Pterynotus) propeposti*
- *Dermomurex (Takia) portelli*, n. sp.

River Bend Formation, North Carolina
- *Dermomurex (Takia) portelli*, n. sp.

LATE OLIGOCENE/EARLY MIOCENE

Tampa Limestone, Florida
- *Pterynotus (Pterynotus) postii*
- *Poirieria (Panamurex) heilprini*
- *Dermomurex (Takia) sexangulus*

Flint River Formation, Georgia
- *Pterynotus (Pterynotus) rufirupicolus*

"Silverdale Beds" (= Silverdale Formation = Belgrade Formation), North Carolina
- *Pterynotus (Purpurellus) repetiti*
- *Dermomurex (Takia) sexangulus*

LATE EARLY MIOCENE

Cantaure Formation, Venezuela
- *Poirieria (Panamurex) gatunensis*
- *Poirieria (Panamurex) improcerus*, n. sp.
- *Poirieria (Panamurex) gibsonsmithi*, n. sp.

Chipola Formation, Oak Grove Sand, Florida
- *Pterynotus (Pterynotus) praepatagiatus*, n. sp.
- *Pterynotus (Pterynotus) hoerlei*
- *Poirieria (Panamurex) laccapoia*
- *Poirieria (Panamurex) fusinoides*
- *Poirieria (Panamurex) lychnia*
- *Poirieria (Panamurex) mauryae*
- *Dermomurex (Dermomurex) matercula*
- *Dermomurex (Trialatella) farleyensis*
- *Dermomurex (Takia) curviductus*
- *Dermomurex (Takia) vaughani*
- *Calotrophon phagon*

Unnamed formation, Chiapas, Mexico
- *Poirieria (Panamurex) laccapoia*

MIDDLE MIOCENE

Shoal River Formation, Florida
- *Poirieria (Panamurex) laccapoia*
- (?)*Poirieria (Panamurex) fusinoides*
- *Calotrophon phagon*

LATE MIOCENE

Cercado Formation, Dominican Republic
- *Dermomurex (Trialatella) pterynoides*
- *Attiliosa aldridgei*

Caujarao Formation, Venezuela
- *Poirieria (Panamurex) improcerus*, n. sp.

PLIOCENE

Melajo Clay, Trinidad
- *Calotrophon hutchisoni*

Gatun Formation, Panama
- *Poirieria (Panamurex) gatunensis*

Punta Gavilán Formation, Venezuela
- *Poirieria (Panamurex) gatunensis*
- *Poirieria (Panamurex) rutschi*, n. sp.

Esmeraldas Beds, Ecuador (East Pacific)
- *Poirieria (Poirieria) actinophora*

Gurabo Formation, Dominican Republic
- *Pterynotus (Pterynotus) aliculus*
- *Pterynotus (Pterynotus) neotripterus*

Pterynotus (Pterynotus) phyllopterus
Pterynotus (Purpurellus) mirificus
Poirieria (Paziella) dominicensis
Poirieria (Flexopteron) collata
Poirieria (Panamurex) gabbi
Aspella castor
Dermomurex (Dermomurex) granulatus
Dermomurex (Dermomurex) cracentis
Dermomurex (Dermomurex) olssoni
Dermomurex (Trialatella) pterynoides
Attiliosa aldridgei

Concepcion Inferior Formation, Mexico
Poirieria (Paziella) dominicensis
Poirieria (Paziella) septima
Poirieria (Panamurex) alaquaensis

Mao Formation, Dominican Republic
Poirieria (Flexopteron) collata

Agueguexquite Formation, Mexico
Poirieria (Pazinotus) bowdenensis
Poirieria (Panamurex) alaquaensis

Duplin Formation, North Carolina
Calotrophon ostrearum

Fruitville Formation (= "Pinecrest Beds"), Florida
Poirieria (Panamurex) clarksvillensis
Aspella senex
Dermomurex (Dermomurex) alabastrum (as *D. engonatus*)
Calotrophon conradi
Calotrophon ostrearum
Acantholabia sarasotaensis

Pinecrest Beds, Florida
Poirieria (Panamurex) clarksvillensis
Dermomurex (Dermomurex) alabastrum (as *D. engonatus*)
Calotrophon ostrearum

Tamiami Formation, Florida
Pterynotus (Pterynotus) phyllopterus
Poirieria (Panamurex) clarksvillensis
Calotrophon ostrearum
Acantholabia floridana

Jackson Bluff Formation, Florida
(?)*Poirieria (Panamurex) alaquaensis*
Poirieria (Panamurex) clarksvillensis
Calotrophon conradi

PLIO-PLEISTOCENE

Caloosahatchee Formation, Florida
Aspella senex
Dermomurex (Dermomurex) alabastrum (as *D. engonatus*)
Calotrophon ostrearum
Acantholabia floridana
Attiliosa aldridgei

Tuberá Group, Colombia
Poirieria (Panamurex) gatunensis
Dermomurex (Dermomurex) alabastrum

Mare Formation, Venezuela
Poirieria (Panamurex) recticanalis
Calotrophon venezuelanus

Playa Grande Formation, Venezuela
Poirieria (Panamurex) recticanalis

Bowden Formation, Jamaica
Poirieria (Flexopteron) collata
Poirieria (Pazinotus) bowdenensis

PLEISTOCENE

Bermont Formation, Florida
Aspella senex
Dermomurex (Dermomurex) alabastrum (as *D. engonatus*)
Dermomurex (Gracilimurex) elizabethae
Dermomurex (Trialatella) antecessor
Calotrophon ostrearum
Attiliosa aldridgei

Anastasia and Ft. Thompson formations, Florida
Calotrophon ostrearum

Waccamaw Formation, South Carolina
Aspella senex
Dermomurex (Dermomurex) alabastrum
Calotrophon ostrearum

Moín Formation, Costa Rica
Pterynotus (Pterynotus) havanensis
Pterynotus (Pterynotus) phyllopterus
Poirieria (Pazinotus) bowdenensis
Dermomurex (Dermomurex) pacei
Dermomurex (Dermomurex) pauperculus
Dermomurex (Dermomurex) alabastrum
Dermomurex (Dermomurex) sarkini, n. sp.
Dermomurex (Trialatella) antecessor
Attiliosa aldridgei

Unnamed formation, Panama
Dermomurex (Dermomurex) pauperculus

RECENT

Pterynotus (Pterynotus) guesti, phaneus, havanensis, lightbourni, radwini, phyllopterus, xenos
Pterynotus (Pterochelus) ariomus
Poirieria (Poirieria) actinophora
Poirieria (Paziella) atlantis, petuchi, n. sp., *pazi, nuttingi, oregonia*
Poirieria (Pazinotus) bowdenensis, stimpsonii, (?) hystricina
Poirieria (Panamurex) carnicolor, velero, eugeniae, n. sp.
Aspella castor, senex, cryptica, morchi
Dermomurex (Dermomurex) olssoni, pacei, pauperculus, alabastrum, sarasuae, n. sp., *binghamae*, n. sp., *kaicherae, glicksteini, worsfoldi*, n. sp.
Dermomurex (Gracilimurex) elizabethae
Dermomurex (Trialatella) antecessor (as *D. cuna*), *abyssicola, oxum, leali*
Calotrophon ostrearum, andrewsi
Attiliosa aldridgei, philippiana, species

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and

EMILY H. VOKES

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NATICIDAE (MOLLUSCA:MESOGASTROPODA) FROM THE NEOGENE OF NORTHWESTERN ECUADOR

WILLIAM D. PITT [1, 2] and LOIS J. PITT [2]

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I. ABSTRACT

The Bolivar Trough from Colombia to Ecuador was the longest lasting Neogene seaway allowing for the free movement of molluscan species between the Caribbean and Pacific faunal provinces. This paper is intended to show the relationship of the Ecuadorian Neogene naticid fauna to the fossil and Recent Caribbean and eastern Pacific faunas.

The naticid fauna from the Neogene formations of northwestern Ecuador consists of 17 species, including eight known from the Recent fauna of the Tropical East Pacific, four previously known only from the Caribbean Tertiary, one Caribbean Tertiary and Recent species, previously reported from Ecuador, three previously known only from the Ecuadorian Neogene, and one from the Tertiary of the northern Pacific.

Although it was anticipated that a majority of the species from the Ecuadorian Neogene would have their origin in the Caribbean fauna, only five of the seventeen species can be considered Caribbean species, with only one of those occurring in the Recent Caribbean fauna; however, several others have analogues in the Caribbean and may have originated there, and two have California-Japanese relationships.

II. INTRODUCTION

It is generally accepted that for much of the Tertiary Period the Caribbean Sea was connected to the Pacific Ocean through the Isthmus of Panamá. Saito (1976) has suggested that the closure took place about 3.5 million years ago. Jones and Hasson (1985) discussed reasons for accepting times between 5.7 Ma and 1.8 Ma, and concluded that 3.5 Ma was the most likely time when the migration of species ended, with total emergence of the isthmus at 3.0 Ma or later.

The faunas of the Neogene formations of northwestern Ecuador have a fairly large proportion of their species with either a direct or indirect relationship to Cenozoic species of the Caribbean or to the Recent eastern Pacific fauna. This paper will discuss the naticid species from four Neogene formations of northwestern Ecuador ranging in age from Late Miocene to Late Pliocene and their relationships to Caribbean and Pacific faunas.

The purpose of this study is to show the relationship of the Neogene naticids of northwestern Ecuador to the Caribbean and Pacific faunas, fossil and Recent. It is not intended to be a monograph of the Family Naticidae.

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Naticids are a taxonomically difficult group, as there are not many distinct morphological features or color patterns, leaving many species on a world-wide basis seemingly closely allied and possibly, in many cases, only ecological varients. One example is the close relationship between *Neverita (Glossaulax) reclusiana* (Deshayes) and the Japanese *N. (G.) didyma didyma* (Röding) (see Majima, 1989, p. 53-58). There is still much work to be done to sort out the differences among the world-wide naticids and until this is done it is appropriate to retain many local names.

Of the 17 species covered in this report only five have Caribbean counterparts; the largest group, consisting of eight species, is living in the eastern Pacific; three are endemic, known only from the Esmeraldas beds; one is known only from the northern Pacific fossil record. Table I shows the species involved and their affiliations.

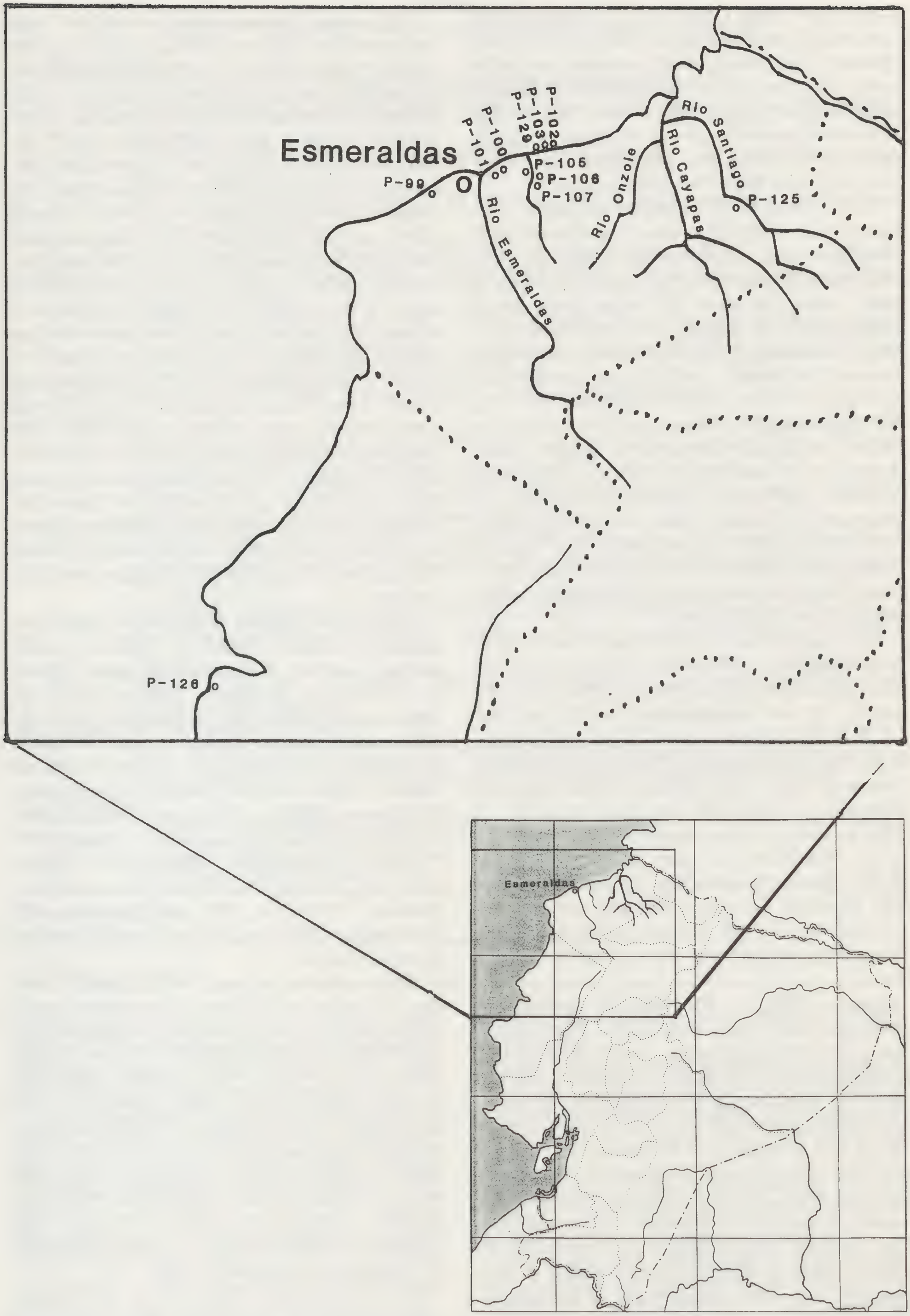
Stratigraphic relationships have always been a problem in northwestern Ecuador. There have been a number of people that have worked on these problems in this part of Ecuador at different times and places. There has been no correlation between the known fossil localities, unless some of this work was done by early oil explorations, in which case the records are in company files and are unavailable.

The Angostura Formation of Late Miocene age (planktic foraminiferal zone N.16) is the oldest formation discussed in this paper. This name was first published by Stainforth (1948, p. 142, 143, 146), following an unpublished work of the International Ecuadorian Petroleum Company (I.E.P.C.) by Smith in 1946 (*fide* Bristow and Hoffstetter, 1977, p. 32). The type locality of the Angostura Formation is in the gorge along the Río Santiago near the confluence with Estero Angostura, Esmeraldas Province, Ecuador (text-fig. 1). This locality is the "Cueva de Angostura" of Olsson (1942b, p. 262). Later, Olsson (1964, p. 8) noted that the formation consists predominantly of coarse sandstones and beds of conglomerates, adding that the beds are largely barren of fossils, but in places contain lenses of well preserved mollusks.

There is a fine outcrop of the Angostura Formation at Punta Verde (text-fig. 1, locality P-102), 2 1/4 km east of the village of Río Verde, about 30 km east of the city of Esmeraldas. The outcrop was discovered by Roger Bristow and John Whittaker of the British Geological Survey and of the British Museum (Natural History), Department of Palaeontology, respectively. There are also several minor outcrops, one in the village of Palestina (text-fig. 1, P-105), a few kilometers west of Río Verde and others (text-fig. 1, P-106, P-107), along a road south from Palestina to El Alto. The Angostura Formation is the Ecuadorian equivalent of the Gatun Formation of Panamá and is considered to be Late Miocene (N. 16), by Whittaker (1988, p. 10). Woodring (1957, p. 47) placed the Gatun Formation in the Miocene but Vokes (1990, p. 4) noted that there is no positive dating of the Gatun Formation and considered the Gatun to be probably Early Pliocene in age. She believes that the resemblance between the Angostura and Gatun faunas is due more to facies than age.

The faunas at Punta Verde and Palestina vary somewhat and probably represent a facies rather than a time difference. Mollusk specimens are abundant at both localities, with *Turritella* the predominant genus. The outcrops along the road to El Alto contain few specimens, mainly pelecypod fragments and several examples of *Neverita (Glossaulax) reclusiana* (Deshayes). The deposits at Palestina afforded specimens of *Neverita (Glossaulax) pabloensis* (Clark) and *Neverita (Glossaulax) reclusiana* (Deshayes). There was mixing of these two species at some localities, but there were only a few specimens from any locality, making integration or separation of the two species impossible to determine based on specimens studied from these localities.

The name Cachabí Formation was first published by Mosquera (1949, p. 18, 21), following an unpublished work of the I.E.P.C. by Smith in 1946 (*fide* Bristow and Hoffstetter, 1977, p. 64), and was considered to be Pleistocene in age. Olsson (1964, p. 10, 11) considered the deposits at Barro Colorado, along the Río Santiago, which is very near the type locality of the Cachabí Formation, to be referable to the Borbón Formation, of Late Miocene or Early Pliocene age. Savoyat *et al.* (1970) considered the Cachabí Formation to be questionably Pliocene in age. The fauna near the village of Barro Colorado, as



Text-figure 1. Map of northwestern Ecuador; showing Pitt (P) collecting localities.

noted by Olsson (1964, p. 11), consists of 10 species of which 50% are Recent Panamic species. However, with several probable synonyms and with the addition of *Natica (Stigmaulax) guppiana* Toula, we find a different percentage of Recent species. *Natica (Stigmaulax) guppiana* is considered to be a Mio-Pliocene species.

The Cachabí Formation consists of a blue sand referred to as a "hardened ash" (Bristow and Hoffstetter, 1977, p. 64), whereas the Borbón Formation consists of gray, blue, medium to large-grain sand, compacted in banks, interbedded with gray volcanics, resting uncomformably above the Onzole and Playa Grande formations (Bristow and Hoffstetter, 1977, p. 58). Stratigraphic sequences are difficult to follow along the banks of a jungle river; therefore, it would seem more appropriate to retain the name Cachabí Formation, as proposed by Smith (1946), rather than Borbón Formation, as proposed by Olsson (1942, p. 261, 262) and to place it at the Miocene-Pliocene boundary until further mapping is done in this area.

The name Onzole Formation (latest N.16 to earliest N.21; Whittaker, 1988, p. 11) was first published by Stainforth (1948, p. 143), based on an unpublished work of the I.E.P.C. by Smith in 1946. The type locality is on the Río Onzole to the east of the Río Cayapas, above the village of San Jose de Cayapas, on the Río Cayapas (text-fig. 1) where most of the fossiliferous deposits occur. We have not seen the type locality of the Onzole Formation or the locality at San Jose de Cayapas, for just before we were there a rain raised the level of the Río Cayapas and we were unable to collect.

Olsson (1964, p. 10) listed 16 species of mollusks from the Picaderos Formation along the Río Santiago, one-half of these belonging to Caribbean Miocene faunas with the rest being new species. Bristow and Hoffstetter (1977, p. 219, 232) considered the Picaderos Formation to correspond to the Onzole Formation (also see Savoyat *et al.*, 1970) and for this reason the name Picaderos Formation is in disuse. The species of the Picaderos Formation of Olsson (1964, p. 10) are closely allied to the species of the Angostura Formation. Savoyat *et al.*, (1970) placed the base of the Onzole Formation along the Río Santiago (see Bristow and Hoffstetter, 1977, p. 220).

The name "Esmeraldas Formation" was proposed by Olsson (1942b, p. 260) for the highly "foraminiferal, tuffaceous shales so extensively exposed along the coast of Esmeraldas and along the Esmeraldas River itself." Bristow and Hoffstetter (1977, p. 143) recognized the name Esmeraldas Formation of Olsson (1942) but considered it in reality to be the Onzole Formation. Olsson (1964, p. 12) considered his Esmeraldas Facies to be equivalent to the Borbón Formation, differing only by the depositional zone. Vokes (1988, p. 4) found it difficult to accept the name Onzole Formation for the highly fossiliferous, mollusk-rich, shallow-water gravity-flows along the Esmeraldas coast from Punta Gorda to Punta Verde and used the term "Esmeraldas beds" for these deposits located at the top of the Onzole Formation. We consider it best to use the term "Esmeraldas beds" for these deposits to avoid confusion between these strata and the lower Onzole beds at Punta Verde, and along the Río Cayapas and Río Onzole.

The name Bahía Formation was proposed by Olsson (1942b, p. 256) for a cliff-section south of Bahía de Caráquez, Manabí Province, Ecuador. Bristow (1976, p. 198) and Bristow and Hoffstetter (1977, p. 59) considered the deposits south of Bahía at Punta La Colorada (= Punta Mesita of recent maps) to be Borbón Formation. Whittaker (1988, p. 24) later re-introduced the term Bahía Formation to replace the "Upper Calcareous" Member of Marks (1951, p. 32) and the Borbón Formation of Bristow (1976, p. 195) and Bristow and Hoffstetter (1977, p. 58) for the cliff section south of Bahía.

The authors, along with Harold and Emily Vokes of Tulane University made collections at the following localities: ANGOSTURA FORMATION – Punta Verde (text-fig. 1, P-102, P-103, P-129), Palestina (P-105), and (P-106, P-107), along the road to El Alto, from Palestina; ESMERALDAS BEDS – Quebrada Camarones (P-100), the road cut south of Camarones (P-101), and Punta Gorda (P-99); CACHABÍ FORMATION – Barro Colorado (P-125); and BAHÍA FORMATION – in the cliffs south of Bahía de Caráquez (P-126).

The Angostura Formation at Punta Verde needs a low Spring tide for collecting, as in the Fall it can be covered with sand. The locality is very good in terms of

TABLE I
THE NATICID FAUNA OF NORTHWESTERN ECUADOR

I. East Pacific
   1. (R)* NATICA (NATICA) INEXPECTANS (Esmeraldas beds)
   2. (R)* NATICA (NATICARIUS) SCETHRA (Esmeraldas beds; Charco Azul Formation)
   3. (R) NATICA (STIGMAULAX) BRODERIPIANA (Esmeraldas beds; Canoa and Charco Azul formations)
   4. (R) POLINICES (POLINICES) INTEMERATUS (Bahía Formation; Gulf of California; Pleistocene)
   5. (R) POLINICES (POLINICES) OTIS (Esmeraldas beds)
   6. (R) POLINICES (POLINICES) PANAMAENSIS (Esmeraldas beds; Charco Azul Formation)
   7. (R)* NEVERITA (GLOSSAULAX) RECLUSIANA (Angostura and Gatun formations; Charco Azul Formation?; numerous Eocene to Pleistocene deposits from Washington to the Gulf of California)
   8. (R) SINUM cf. CYMBA (Esmeraldas beds; Galápagos Islands)

II. Caribbean
   1. NATICA (STIGMAULAX) GUPPIANA (Angostura, Cachabí, Shoal River, La Vela, Río Banano, and Gatun formations; Tubará Group)
   2. POLINICES (POLINICES) CAROLINIANUS (Esmeraldas beds; Duplin, Jackson Bluff, Fruitville, and Mare formations)
   3. (r) POLINICES (POLINICES) HEPATICUS (Angostura, Cachabí, Progreso, Zorritos, Springvale, Gurabo, Gatun, Río Banano, and Bowden formations; Tubará Group)
   4. POLINICES (POLINICES) STANISLASMEUNIERI (Angostura, Progreso, La Vela, Springvale, Gurabo, Gatun, and Río Banano formations; Tubará Group)
   5. POLINICES (POLINICES) LAVELANA (Esmeraldas beds; La Vela and Bowden formations)

III. California – Northern Pacific
   1. NEVERITA (GLOSSAULAX) PABLOENSIS (Angostura and Gatun formations; numerous Miocene localities from central to southern California)

IV. Endemic
   1. NATICA (STIGMAULAX) LANDESIANA
   2. POLINICES (EUSPIRA) ELLA
   3. SINUM LACONDAMINI

17 species total
R – living in eastern Pacific; *no longer on the Ecuadorian coast
r – living in Atlantic

diversity and number of specimens, and together with the localities in and around Palestina, are the only Angostura Formation localities that are easily accessible.

Exposures of the Esmeraldas beds of the Onzole Formation include: the intertidal exposures at Punta Gorda, which appear to be gone, although we did obtain a few specimens, and with a very low Spring tide, parts may remain; Quebrada Camarones, which at one time was a fine collecting locality, with material from the talus slope, but has been poor more recently; and the road cut south of Camarones, another fine locality now overgrown with vegetation.

Exposures of the Cachabí Formation along the Río Santiago are best collected in the Fall when the river level is usually low, as most of the outcrops are in the river bank.

The Bahía Formation in the cliff-section south of Bahía needs a low tide to be readily accessible and fossils are sparse.

The excellent section along the coastal cliffs north of the village of Río Verde, according to Whittaker (1988, p. 10), contains an exposed Miocene (N.12) section of the

Viche Formation, which is overlain by the presumably Late Miocene Angostura Formation (N.16). The age is uncertain as these shallow-water deposits contain only a few, poorly preserved benthic foraminifers. The Angostura Formation is overlain by the Late Miocene, Lower Onzole Formation (latest N.16; Whittaker, 1988, p. 11).

Olsson (1964, p. 8) noted that many species from the Angostura Formation are very closely related to Gatun species and differ only in minor details. These minor differences may be more a difference in facies than in time, or *vice versa*.

III. ACKNOWLEDGMENTS

We want to thank Harold and Emily Vokes of Tulane University for their encouragement, help in the field, and use of the University collections. We especially want to thank Emily Vokes without whose help this manuscript would not have been possible. We also thank the following persons for making museum collections available: Peter Hoover, Paleontological Research Institution; James McLean, Gale Sphon, and Lindsey Groves, Natural History Museum of Los Angeles County; Thomas Waller and Warren Blow, United States National Museum of Natural History. Thanks also go to Roger Bristow, British Geological Survey, Exeter, England and John Whittaker, Department of Palaeontology, British Museum (Natural History), for making available their unpublished information and locality data from Ecuador, as well as making the museum collections available. We are grateful to Allan McMakin for the photography and Wayne Barnett for the original ultra-violet light photograph of *Natica guppiana* from the Gatun Formation. Finally for reviewing this manuscript and offering their helpful criticism we want to thank Alan Kabat of the United States National Museum; Louie Marincovich of the United States Geological Survey, Menlo Park, California; Ryuichi Majima of Yokohama National University, Japan.

ABBREVIATIONS FOR REPOSITORY INSTITUTIONS

ANSP – Academy of Natural Sciences, Philadelphia, Pennsylvania
BM(NH) – British Museum (Natural History)
CAS – California Academy of Sciences, San Francisco, California
LACM – Museum of Natural History, Los Angeles County, Los Angeles, California
PRI – Paleontological Research Institution, Ithaca, New York
TU – Tulane University, New Orleans, Louisiana
UCMP – Museum of Paleontology, University of California, Berkeley
USNM – United States National Museum of Natural History
SU – Stanford University, collections now at California Academy of Sciences

IV. SYSTEMATIC PALEONTOLOGY

Class GASTROPODA
Order MESOGASTROPODA
Superfamily NATICACEA
Family NATICIDAE Forbes, 1838
Subfamily POLINICINAE
Finlay and Marwick, 1937
Genus POLINICES Montfort, 1810

Polinices MONTFORT, 1810, Conchyliologie Systematique, v. 2, p. 223, pl. 56.

Type species: Polinices albus Montfort, 1810 by original desig. (= *Nerita mammilla* Linnaeus, 1758).

Subgenus POLINICES s.s.
POLINICES (POLINICES) CAROLINIANUS
(Conrad)
Plate 1, figures 1-4

Natica caroliniana CONRAD, 1841, Amer. Jour. Sci., (ser. 1) v. 41, p. 347, pl. 2, fig. 18; CONRAD, 1868, Amer. Jour. Conchology, v. 4, p. 65, pl. 6, fig. 3.
Polinices (*Mammillaria*?) *caroliniana* (Conrad). MANSFIELD, 1930, Florida State Geol. Surv., Bull. 3, p. 127, pl. 19, fig. 1.
Polinices (*Polinices*) *caroliniana* (Conrad). OLSSON and HARBISON, 1953, Acad. Nat. Sci. Phila., Mon. 8, p. 268, pl. 57, fig. 6.
Polinices subclausus (Sowerby). WEISBORD, 1962, Bulls. Amer. Paleontology, v. 42, no. 193, p. 241 [in part], pl. 22, fig. 13, 14 [not figs. 11, 12, 15, 16, *P. hepaticus* (Röding, 1798)].

Description: Shell of medium size, globose; spire evenly tapered; suture appressed; parietal callus heavy; columella with large funicular rib, bordered by a deep sulcus extending from the columella wall, anteriorly, around the funicular rib to the parietal callus, and reaching the columellar wall.

Holotype: ANSP 15149.
Type locality: Natural Well, North Carolina.
Occurrence: Esmeraldas beds, Ecuador. Duplin Formation, North Carolina; Jackson Bluff and Fruitville formations (="Pinecrest Beds"), Florida; Pliocene. Mare Formation, Venezuela; Pleistocene.

Discussion: Specimens of *Polinices carolinianus* (Conrad) (USNM 114425-topotypes) examined vary in that some specimens have a depression below the suture, on the body whorl, also a slight hook on the columellar wall, posterior to the funicular rib; however, these features are variable. Specimens of *P. carolinianus* (Conrad) from the Esmeraldas beds, also have a slight depression just below the suture making the body whorl appear slightly shouldered. Ecuadorian specimens do not have the sulcus ending as close to the columellar wall posteriorly as do specimens from the type locality; in specimens examined from Florida this appears to be a variable feature throughout the range. *Polinices boutakoffi* Rutsch (1942, p. 139, pl. 6, figs. 7a, 7b) is a close ally that differs in having a deeper grove on the parietal callus, is more inflated, and is not as appressed at the suture.

Polinices carolinianus probably originated in the Caribbean with the specimens from the Esmeraldas beds representing the western extreme for this species, now extinct in the Tropical East Pacific.

Polinices (Polinices) hepaticus (Röding)

Plate 1, figures 5-10

Albula hepatica RÖDING, 1798, Mus. Bolten., pt. 2, p. 21.
Natica subclausa SOWERBY, 1850, Geol. Soc. London, Quart. Jour., v. 6, p. 51.
Polinices (Polinices) subangulata NELSON, 1870, Connecticut Acad. Arts and Sci., Trans., v. 2, art. 5, p. 195 [in part], pl. 6, fig. 4 [not figs. 12, 13].
Polinices subclausa (Sowerby). BROWN and PILSBRY, 1911, Acad. Nat. Sci. Phila., Proc., v. 63, p. 360; MAURY, 1917, Bulls. Amer. Paleontology, v. 5, no. 29, p. 300(136), pl. 23, fig. 14; OLSSON, 1922, *ibid.*, v. 9, no. 39, p. 329(157), pl. 13, figs. 16, 17; HODSON, HODSON, and HARRIS, 1927, *ibid.*, v. 13. no. 49, p. 69, pl. 36, fig. 5; ANDERSON, 1929, Calif. Acad. Sci., Proc., (ser. 4) v. 18, no. 4, p. 124.
Polinices brunnea subclausa (Sowerby). WOODRING, 1928, Carnegie Inst. Washington, Publ. 385, p. 385, pl. 30, fig. 13.
Polinices (Mammilla) cf. *brunnea* (Link). WEISBORD, 1929, Bulls. Amer. Paleontology, v. 14, no. 54, p. 261(29), pl. 9, fig. 12.
Polinices (Polinices) nelsoni OLSSON, 1932, Bulls. Amer. Paleontology, v. 19, no. 68, p. 208, pl. 24, figs. 8, 10.
Polinices brunneus subclausus (Sowerby). WOODRING, 1957, U.S. Geol. Surv., Prof. Paper 306-A, p. 89, pl. 20, fig. 9.
Polinices subclausus (Sowerby). WEISBORD, 1962, Bulls. Amer. Paleontology, v. 42, no. 193, p. 241 [in part], pl. 22, figs. 11, 12, 15, 16 [not figs. 13, 14; = *P. carolinianus* (Conrad, 1841)].

Description: Shell of medium size; spire height medium to high, evenly tapered; suture appressed; parietal callus heavy, with a transverse groove posteriorly, junction of parietal and columellar callus posterior to center of aperture opening, at which point a narrow columellar callus tapers to a point anteriorly; umbilicus open with funicular rib indistinct to lacking.

Type material: Chemnitz, 1781, pl. 189, figs. 1932, 1933; no certain type material can be traced today (Zoologisk Museum, Copenhagen, Denmark; written comm.).

Type locality: Uncertain, possibly West Indies.

Occurrence: Angostura, Cachabí and Progreso formations, Esmeraldas beds, Ecuador. Zorritos Formation, Peru; Springvale Formation, Trinidad; Miocene. Gurabo Formation, Dominican Republic; Mio-Pliocene. Gatun Formation, Panamá; Río Banano Formation, Costa Rica; Pliocene. Tubará Group, Colombia; Plio-Pleistocene. Bowden Formation, Jamaica; Pleistocene. Recent, Texas, West Indies to Brazil.

Discussion: Although the spire is fairly consistent in height, the shell is globose to rather slender and the width of the umbilical opening varies from narrow to wide. Recent examples of *P. hepaticus* differ in having a lower spire than most specimens studied in this report, otherwise the two are morphologically equal.

Maury (1917, p. 300(136) noted that some specimens of *P. subclausus*, a synonym of *P. hepaticus*, retain a color pattern of gray stripes and for this reason she felt that *P. subclausus* was distinct from its Recent analogue. One of her specimens of *P. subclausus* (PRI 33113) examined does have gray axial streaks, as do several specimens of *P. hepaticus* from locality TU 1358 (see pl. 1, fig. 6). Some Recent specimens examined at Tulane and USNM also have these axial streaks. Most specimens of *P.*

hepaticus are of a solid color, and this color pattern of axial streaks on some specimens (fossil and Recent) does not warrant treating these as a distinct species as believed by Maury.

Polinices subclausus, as figured by Weisbord (1962, pl. 22, figs. 11-16), represents two species: figures 11, 12, 15, 16 represent *P. subclausus;* figures 13, 14 represent *P. carolinianus* (Conrad).

In his remarks when describing *P. nelsoni*, a synonym of *P. hepaticus*, Olsson (1932, p. 209) noted that *P. subangulata* Nelson (1870 [in part], pl. 6, fig. 4 [not figs. 12, 13] is probably this species, as the young shells of *P. subangulata* do not differ greatly from adult shells in form.

Polinices prolactea Anderson (1929, p. 124, pl. 14, figs. 8, 9) differs in having a lower spire, a smaller umbilical opening, and has the junction of the columellar callus and the parietal callus at the center of the aperture opening. This species may prove to be a synonym of the Recent *P. lacteus* (Guilding, 1834).

In the Tropical East Pacific *P. hepaticus* is closely allied in form to the group of white *Polinices* discussed under *P. stanislasmeunieri*, the closest species morphologically being *P. panamaensis* (Récluz, 1844), which differs mainly in lacking the transverse groove on the parietal callus and having a much narrower umbilical opening.

Polinices hepaticus has a living relative in *P. lacteus* (Guilding) in the Atlantic, as well as the white *Polinices* group in the Tropical East Pacific. *Polinices hepaticus* is widespread in the Caribbean Neogene and it is not surprising to find it in the Neogene of the Tropical East Pacific, as a number of species that occur in the Caribbean Neogene also occur in the Peruvian Miocene, including *Turritella abrupta* Spieker, which was described from Peru. Since *P. hepaticus* is widspread in the Caribbean Neogene and Recent, but only sparingly in the Tropical East Pacific Neogene, it probably arose in the Caribbean.

Polinices (Polinices) intemeratus (Philippi)

Plate 2, figure 1

Natica intemerata PHILIPPI, 1851, Systematisches Conchylien-Cabinet, v. 2, pt. 1, p. 129, pl. 18, fig. 10; PHILIPPI, 1853, *ibid.*, p. 233, 234; TRYON, 1886, Manual Conchology, v. 8, p. 46, pl. 18, fig. 83, pl. 19, fig. 93.

Polinices uber var. *intemeratus* (Philippi). DALL, 1908, Harvard Mus. Comp. Zool., Bull., v. 43, no. 6, p. 334. *Natica alabaster* REEVE, 1855, Conch. Icon., v. 9, *Natica*, pl. 9, figs. 33a, 33b. KEEN, 1971, Sea Shells

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PLATE 1

Figures — Page

1-4. *Polinices (Polinices) carolinianus* (Conrad) 114

1. CASG 66565; height 33.8 mm, diameter 26.7 mm (X 1.5).
   Locality: TU 60, Florida; Jackson Bluff Formation.
2. CASG 66566; height 23.8 mm, diameter 21.5 mm (X 2).
   Locality: TU 1000, Florida; "Pinecrest Beds."
3. CASG 66567; height 24.5 mm, diameter 21.3 mm (X 1.8).
   Locality: P-100, Ecuador; Esmeraldas beds.
4. CASG 66568; height 28.8 mm, diameter 27.2 mm (X 1.3).
   Locality: TU 376, North Carolina; Duplin Formation.

5-10. *Polinices (Polinices) hepaticus* (Röding) 115

5. CASG 66569; height 33.8 mm, diameter 21.8 mm (X 1.4).
   Locality: TU 1377, Dominican Republic; Cercado Formation.
6. CASG 66570; height 29.5 mm, diameter 23.8 mm (X 1.5).
   Locality: TU 1358, Dominican Republic; Cercado Formation.
7. CASG 66571; height 26.1 mm, diameter 20.8 mm (X 1.9).
   Locality: P-100, Ecuador; Esmeraldas beds.
8. CASG 66572; height 22.0 mm, diameter 18.9 mm (X 1.8).
   Locality: P-103, Ecuador; Angostura Formation.
9. LACM 147856; height 32.0 mm, diameter 26.0 mm (X 1.4).
   Locality: LACM A-2777, Veracruz, Mexico; Recent.
10. CASG 66573; height 24.9 mm, diameter 19.9 mm (X 1.5).
    Locality: P-101, Ecuador; Esmeraldas beds.

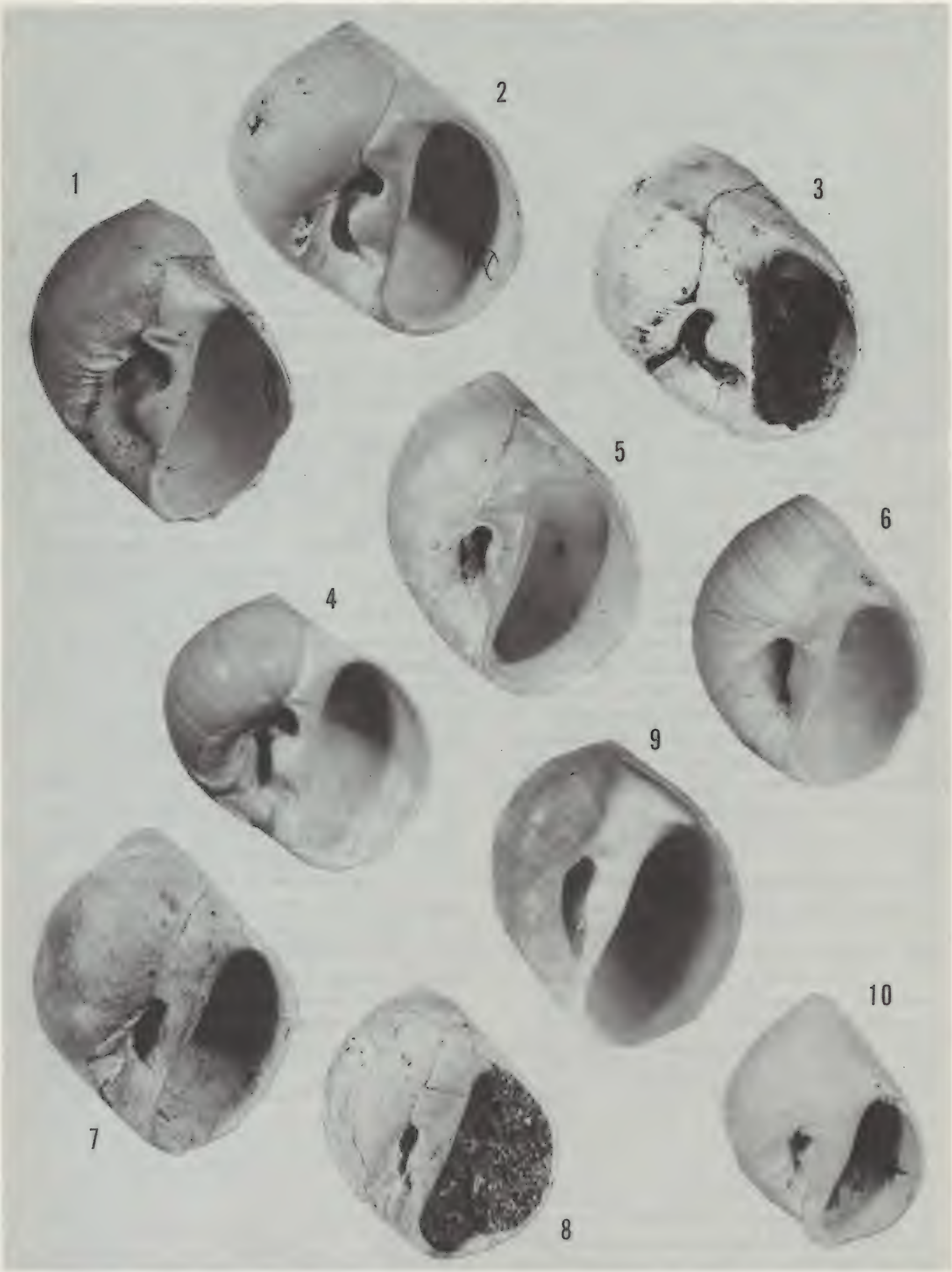

PLATE 1

Trop. West Amer., ed. 2, p. 478; MARINCOVICH, 1977, Bulls. Amer. Paleontology, v. 70, no. 294, p. 253.

Polinices (Polinices) intemeratus (Philippi). KEEN, 1971, Sea Shells Trop. West Amer., ed. 2, p. 478, fig. 877; MARINCOVICH, 1977, Bulls. Amer. Paleontology, v. 70, no. 294, p. 253, pl. 22, figs. 8, 9.

Description: Shell of medium size; globose, of about four whorls; spire low, suture appressed; parietal callus heavy with junction of parietal and columellar callus posterior to center of apertural opening at which point the columella callus tapers to a point anteriorly; umbilicus open with an indistinct funicular rib.

Holotype: Unknown, presumably at BM(NH).

Type locality: Gulf of California, Mexico.

Occurrence: Bahía Formation, Ecuador. Carmen Island, Gulf of California, Baja California, Mexico; Pleistocene. Recent, Cedros Island, western Baja California, Mexico, throughout the Gulf of California, south to the Galápagos Islands and Peru.

Discussion: *Polinices intemeratus* (Philippi) is part of a large group of white *Polinices* discussed by Keen (1971, p. 480) and in this paper under *P. stanislasmeunieri*. *Polinices intemeratus* is related to *P. hepaticus* from the Caribbean and Peruvian Miocene, but differs in being more globose with a much lower spire.

The figured specimen is from Punta Mesita (P-126), Bahía Formation (*fide* Whittaker, 1988, p. 24). Punta Mesita (of recent maps) equals Punta La Colorada of Bristow and Hoffstetter (1977, p. 59), and is on the southern edge of Bahía de Caráquez, Manabí Prov., Ecuador. Bristow and Hoffstetter (1977, p. 59) included a faunal list of the Borbón Formation (= Bahía Formation) from the cliffs south of Bahía. A number of the species have been tentatively identified as those occurring in the Gatun Formation of Panamá, such as *Turritella abrupta* Spieker, *T. gatunensis* Conrad, *T. altilira* Conrad and *Polinices brunneus* (Link) (= *P. hepaticus* Röding, 1798). Our specimens from Punta Mesita, south of Bahía, are treated as *Polinices intemeratus* because of the low spire, which we have not observed in *P. hepaticus*. The specimens on the faunal list of Bristow and Hoffstetter (1977) have not been studied by us and we can only assume that our specimens are probably the same as those of Bristow and Hoffstetter.

Polinices (Polinices) lavelana
F. Hodson
Plate 2, figures 2, 3

Polinices subclausa lavelana F. HODSON *in* HODSON, HODSON and HARRIS, 1927, Bulls. Amer. Paleontology, v. 13, no. 49, p. 69, pl. 36, fig. 8, pl. 37, figs. 12, 14; WOODRING, 1957, U.S. Geol. Surv., Prof. Paper 306-A, p. 90.

Description: Shell of medium size, moderately slender to inflated; whorls evenly tapering; suture impressed; parietal callus heavy, columellar callus narrow with a deep notch between parietal and columellar callus; umbilicus deep, with a low funicular rib, bordered by narrow sulcus.

Holotype: PRI 22870.

Type locality: PRI locality 1033; La Vela, Venezuela.

Occurrence: Esmeraldas beds, Ecuador. La Vela Formation, Venezuela; Miocene. Bowden Formation, Jamaica; Pleistocene.

Discussion: *Polinices lavelana* differs from *P. hepaticus* in having a deep notch between the parietal and columellar callus; the funicular rib is more pronounced and is bordered by a narrow sulcus.

Polinices lavelana was described as a subspecies of *P. subclausus*, but that is a synonym of *P. hepaticus*. Both *P. subclausus lavelana* and *P. hepaticus* occur in the Esmeraldas beds; therefore, it becomes necessary to raise *P. lavelana* to full species rank. The authors have not seen both species occurring together at any other locality. However, as larger collections become available for study, these species may prove to merge morphologically and to be synonymous.

Polinices lavelana is similar to some forms of *P. stanislasmeunieri*, a highly variable species. Woodring (1957, pl. 21, fig. 14) figured a specimen of *P. stanislasmeunieri* from the Gatun Formation, Panamá, that has a small notch at the junction of the columella and parietal callus but differs from *P. lavelana* in that the notch is central or anterior to the columellar wall, and the columellar callus is narrow, which is typical in *P. stanislasmeunieri*, rather than at the center or posterior of the center as in the typical *P. hepaticus* or *P. lavelana*. The only known specimens of *P. lavelana* from the Tropical East Pacific are from the Esmeraldas beds (P-101). The specimens from the Esmeraldas beds differ from the

typical *P. lavelana* in that the umbilical notch is deeper, although there are variations among the specimens from the Esmeraldas beds. The difference in the depth of the notch is probably no more than a facies difference. Since *P. lavelana* occurs in the Pleistocene, Bowden Formation, of Jamaica (*fide* Hodson, Hodson, and Harris, 1927, p. 69) it is not surprising to find it in the Pliocene Esmeraldas beds. *Polinices lavelana* is more widespread in the Caribbean than in the Pacific and probably originated in the Caribbean.

POLINICES (POLINICES) OTIS
(Broderip and Sowerby)
Plate 2, figures 4, 5

Natica otis BRODERIP and SOWERBY, 1829, Zool. Jour., London, v. 4, p. 372.
Natica galapagosa RÉCLUZ, 1844, Zool. Soc. London, Proc., (1843), v. 11, p. 213.
Natica unimaculata REEVE, 1855, Conch. Icon., v. 9, *Natica*, pl. 19, figs. 85a, 85b.
Polinices (Polinices) brunneus (Link) subspecies. OLSSON, 1964, Neogene Moll. Northwest. Ecuador, p. 179, pl. 32, figs. 6, 6a, [not of Link, 1807].
Polinices (Polinices) otis (Broderip and Sowerby). KEEN, 1971, Sea Shells Trop. West Amer., ed. 2, p. 478, fig. 879; ABBOTT, 1974, Amer. Sea Shells, p. 155, no. 1686; MARINCOVICH, 1977, Bulls. Amer. Paleontology, v. 70, no. 294, p. 255, pl. 22, figs. 10, 11.
Polinices (Polinices) unimaculatus (Reeve). KEEN, 1971, Sea Shells Trop. West Amer., ed. 2, p. 480, fig. 883.
Polinices (Polinices) galapagosus (Récluz). KEEN, 1971, Sea Shells Trop. West Amer., ed. 2, p. 478, fig. 875.

Description: Spire low to moderately elevated; suture distinct to appressed; body whorl globose; umbilical callus heavy, partially filling umbilicus posteriorly, at which point a transverse groove separates the anterior and posterior lobes, anterior lobe flattened, overhanging umbilicus and becoming slender anteriorly; umbilicus broadly open with wide sulcus; low wide funicular rib originating about center of anterior lobe.

Holotype: Unknown, presumably in BM(NH).
Type locality: Mazatlan, Mexico.
Occurrence: Esmeraldas beds, Ecuador. Recent, Gulf of California to Ecuador.

Discussion: Polinices otis (Broderip and Sowerby), from the Esmeraldas beds, compares favorably to "*P. brunneus* (Link) subspecies" Olsson (1964, p. 179, pl. 32, fig. 6, USNM 645444; the specimen in fig. 6a, USNM 643892, was not received at USNM). "*Polinices brunneus* subspecies" of Olsson is similar to, but differs from, *P. hepaticus* in having a lower spire and much wider umbilicus, bordered by a wide flattened area posteriorly, and is a smaller species (height 20 mm) than the typical *P. hepaticus* (height about 40 mm).

In comparing *P. otis* from the Esmeraldas beds to Recent specimens from the Panamic Province we find that the specimens from the Esmeraldas beds fall within the range of variability for Recent species. Keen (1971, p. 478) noted that *P. galapagosus* (Récluz) is the lowest-spired naticid in the Tropical East Pacific. Marincovich (1977, p. 257) synonymized *P. galapagosus* (type locality, Albemarle Island, Galápagos Islands, Ecuador) with *P. otis* and considered the type locality of *P. galapagosus* to be in error, as *P. otis* is not known to occur in the Galápagos Islands. In his description of *P. otis* he noted that the spire is moderately high. The average height of *P. otis* is about 35 mm, larger than specimens from the Esmeraldas beds, which are about 20 mm.

Polinices otis has not been previously reported in the fossil record of the Tropical East Pacific. *Polinices hepaticus*, a similar species goes back to the Miocene in the Caribbean and Ecuador and occurs in the Recent in the Caribbean. It is probable that *P. otis* arose from this stock.

POLINICES (POLINICES) PANAMAENSIS
(Récluz)
Plate 2, figures 6, 7

Natica panamaensis RECLUZ, 1844, Zool. Soc. London, Proc., (1843), v. 11, p. 208.
Polinices (Polinices) panamaensis (Récluz). OLSSON, 1964, Neogene Moll. Northwest Ecuador, p. 180, pl. 32, fig. 4; KEEN, 1971, Sea Shells Trop. West Amer., ed. 2, p. 478, fig. 880; MARINCOVICH, 1977, Bulls. Amer. Paleontology, v. 70, no. 294, p. 252, pl. 22, figs. 5-7.

Description: Shell globose to moderately elongate; spire moderately elevated; three and one-half smooth nuclear whorls; post-nuclear whorls four; suture slightly impressed; body whorl inflated with rounded angulation below suture, giving body whorl a flat-sided appearance; parietal callus heavy; umbilicus slightly to moderately open; columellar callus narrow, coming to a point anteriorly.

Syntypes: Three syntypes, BM(NH) no. 1964446.

Type locality: Panamá [Pacific Coast].

Occurrence: Esmeraldas beds, Ecuador. Charco Azul Formation, Panamá; Pleistocene. Recent, Mexico to Peru.

Discussion: Olsson (1964, p. 180, pl. 32, fig.4) based his determination of *P. panamaensis* on a single specimen from the Esmeraldas beds at Punta Gorda. This determination will be accepted here allowing for the variability within the species and the fact that there is only one specimen upon which to base a judgment.

In comparing *P. panamaensis* (Récluz) to other species, it has some similarity to *P. hepaticus* (Röding) but differs in being more globose, somewhat flat-sided and lacks the transverse groove on the parietal callus; *P. stanislasmeunieri* Maury differs in having a higher spire, is not as globose and also lacks a transverse groove on the parietal callus. *Polinices panamaensis* is most similar to *P. subangulata* Nelson, 1870 (see pl. 2, fig. 8) from the Peruvian Miocene, which also is flat-sided and lacks a transverse groove on the parietal callus, but differs in being higher spired and less globose. *Polinices panamaensis* possibly arose in the Tropical East Pacific from *P. subangulata*. It may even prove to be a synonym.

Polinices (Polinices) stanislasmeunieri Maury

Plate 2, figures 9-12; Plate 3, figures 1-4

Polinices stanislasmeunieri MAURY, 1917, Bulls. Amer. Paleontology, v. 5, no. 29, p. 300(136), pl. 23, figs. 15, 16; OLSSON, 1922, *ibid.*, v. 9, no. 39, p. 329(157), pl. 13, fig. 7; MAURY, 1925, *ibid.*, v. 10, no. 42, p. 392(240), pl. 40, fig. 7; ANDERSON, 1929, Calif. Acad. Sci., Proc., (ser. 4) v. 18, no. 4, p. 124; WOODRING, 1957, U.S. Geol. Surv., Prof. Paper 306-A, p. 90, pl. 21, figs. 11-14; JUNG, 1969, Bulls. Amer. Paleontology, v. 55, no. 247, p. 483, pl. 48, figs. 16-18.

PLATE 2

Figures Page

1. *Polinices (Polinices) intemeratus* (Philippi) 116
   CASG 66574; height 23.1 mm, diameter 22.0 mm (X 1.9).
   Locality: P-126, Ecuador; Bahía Formation.

2-3. *Polinices (Polinices) levalana* F. Hodson 118

2. PRI 22870 (holotype); height 32.0 mm, diameter 24.0 mm (X 1.3).
   Locality: Venezuela; La Vela Formation.
3. CASG 66575; height 30.9 mm, diameter 25.0 mm (X 1.4).
   Locality: P-101, Ecuador; Esmeraldas beds.

4-5. *Polinices (Polinices) otis* (Broderip and Sowerby) 119

4. CASG 66576; height 33.4 mm, diameter 31.5 mm (X 1.2).
   Locality: TU R-185, Panamá; Recent.
5. CASG 66577; height 21.0 mm, diameter 18.5 mm (X 2).
   Locality: P-100, Ecuador; Esmeraldas beds.

6-7. *Polinices (Polinices) panamaensis* (Récluz) 119

6. CASG 66578; height 41.2 mm, diameter 35.0 mm (X 0.9).
   Locality: Panamá; Recent.
7. USNM 643893; height 31.0 mm, diameter 25.3 mm (X 1.2).
   Locality: Punta Gorda, Ecuador; Esmeraldas beds.

8. *Polinices (Polinices) subangulata* Nelson 120
   PRI 2339 (topotype); height 41.8 mm, diameter 32.6 mm (X 1).
   Locality: Peru; Tumbez Formation.

9-12. *Polinices (Polinices) stanislasmeunieri* Maury 120

9. PRI 28836 (holotype); height 36.0 mm, diameter 28.0 mm (X 1.3).
   Locality: Dominican Republic; Gurabo Formation.
10. CASG 66579; height 23.0 mm, diameter 17.5 mm (X 1.9).
    Locality: P-102, Ecuador; Angostura Formation.
11. CASG 66580; height 28.6 mm, diameter 22.7 mm (X 1.4).
    Locality: P-95, Panamá; Gatun Formation.
12. CASG 66581; height 26.4 mm, diameter 21.7 mm (X 1.9).
    Locality: TU 1377, Dominican Republic; Cercado Formation.

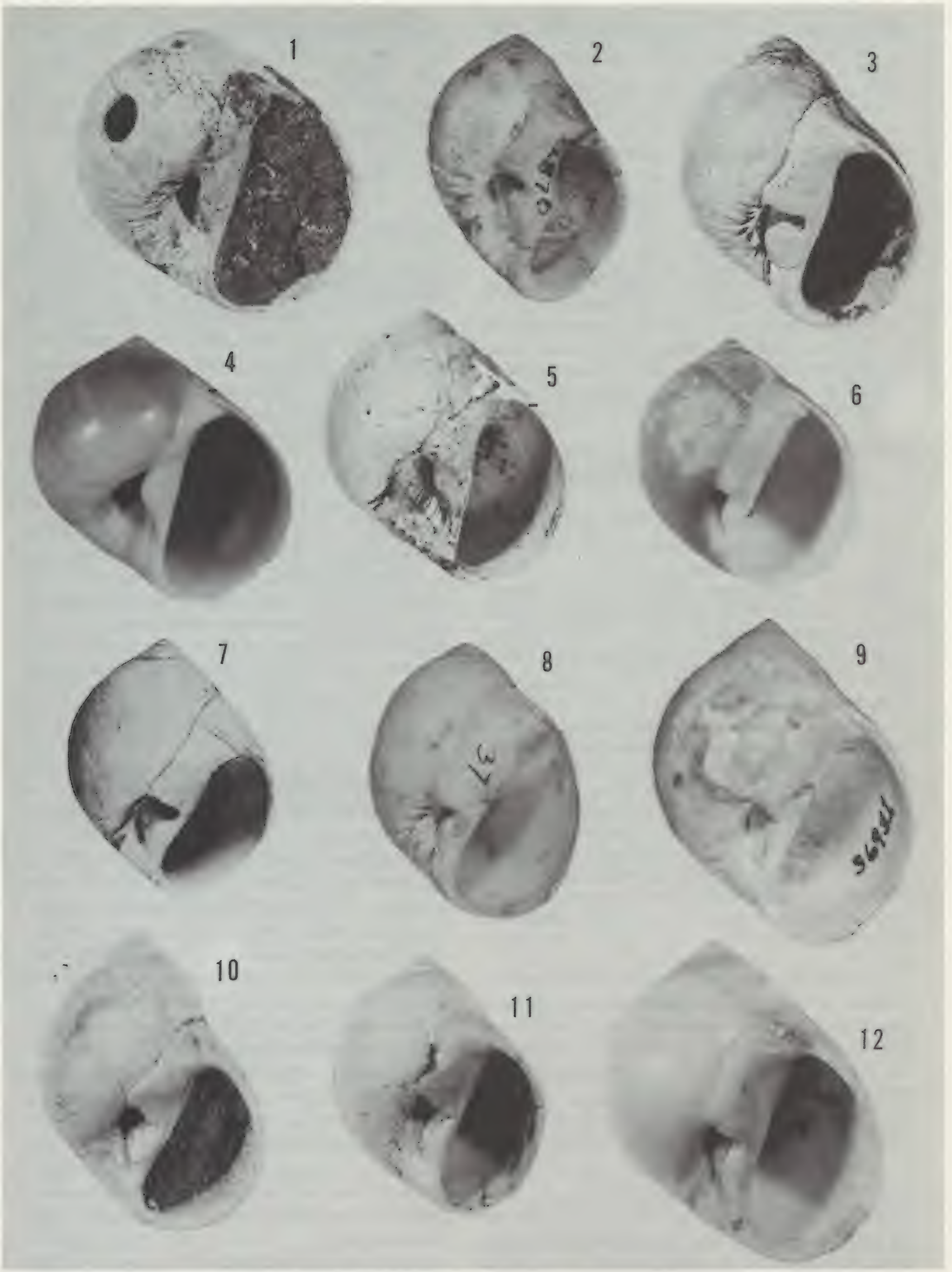

PLATE 2

Natica coronis HANNA and ISRAELSKY, 1925, Calif. Acad. Sci., Proc., (ser. 4) v. 14, no. 2, p. 46, pl. 8, fig. 4.

Polinices caparona MAURY, 1925, Bulls. Amer. Paleontology, v. 10, no. 42, p. 392(240), pl. 40, fig. 5.

Polinices springvalensis MAURY, 1925, Bulls. Amer. Paleontology, v. 10, no. 42, p. 393(241), pl. 40, fig. 6; WOODRING, 1957, U.S. Geol. Surv., Prof. Paper 306-A, p. 90.

Polinices stanislasmeunieri venezuelana F. HODSON *in* HODSON, HODSON, and HARRIS, 1927, Bulls. Amer. Paleontology, v. 13, no. 49, p. 70, pl. 37, figs. 10, 15.

Polinices (Polinices) coronis (Hanna and Israelsky). OLSSON, 1932, Bulls, Amer. Paleontology, v. 19, no. 68, p. 207, pl. 24, fig. 9.

Polinices coronis (Hanna and Israelsky). MARKS, 1951, Bulls. Amer. Paleontology, v. 33, no. 139, p. 368(98).

Polinices (Polinices) cf. *cora* (Orbigny). OLSSON, 1964, Neogene Moll. Northwest. Ecuador, p. 180, pl. 32, fig. 7.

Description: Shell ovate; five and one-half rounded whorls; spire moderately elevated; body whorl slightly concave in front of suture, slender to moderately globose, entire surface smooth, except for growth lines; aperture semicircular; parietal callus heavy, ending with a sharp truncation anterior to center of the columellar wall, anterior callus narrow.

Holotype: PRI 28836.

Type locality: Río Cana, Cerro Gordo to Mao road (Guayubin to Mao telephone line), Dominican Republic.

Occurrence: Angostura and Progreso formations, Ecuador. Zorritos Formation, Peru; La Vela Formation, Venezuela; Springvale Formation, Trinidad; Miocene. Gurabo Formation, Dominican Republic; Mio-Pliocene. Gatun Formation, Panamá; Río Banano Formation, Costa Rica; Pliocene. Tubará Group, Colombia; Plio-Pleistocene.

Discussion: Polinices stanislasmeunieri Maury is part of a widespread complex found in both the Caribbean and the Tropical East Pacific during Mio-Pliocene time. In the Recent fauna of the Tropical East Pacific and Caribbean it is closely related to a large group commonly referred to as "the white *Polinices*." In the discussion of *P. uber* (Valenciennes, 1832), Keen (1971, p. 480), noted: "The degree of variability to admit within this species has been a matter of debate among conchologists. The present practice is to recognize *P. uber* as a central form among a number of related species of white *Polinices,* namely, *P. cora* (Orbigny, 1840), *P. dubius* (Récluz, 1844), and *P. rapulum* (Reeve, 1855), from western South America; *P. lacteus* (Guilding, 1834) and *P. uberina* (Orbigny, 1842) from the Caribbean area; *P. intemeratus, P. lima* and *P. unimaculatus* of the Panamic Province."

Polinices panamaensis is part of the *P. uber* species-group, which includes *P. intemeratus, P. panamaensis* and *P. otis,* This also places it in with the white *Polinices* group as noted by Keen. Of the Recent species from the Tropical East Pacific *P. stanislasmeunieri* is closest to *P. panamaensis,* which also is truncated between the parietal callus and the columellar callus, however, in *P. panamaensis* the columellar callus is heavier, the truncation is less pronounced and the shell is uniformly lower spired and more robust. *Polinices stanislasmeunieri* can at times be a low spired, robust form (*fide* Woodring, 1957, pl. 21, fig. 12) but this is not the norm, and possibly just an aberration.

In separating *P. stanislasmeunieri* from related species the consistant difference is the narrow columellar callus with a low or no funicular rib, a sharp truncation between the narrow columellar callus and the heavier parietal callus; the truncation is at or anterior to the center of the apertural opening. We are placing *P. caparona* Maury, 1925, and *P.* cf. *cora* Olsson, 1964, in synonymy with *P. stanislasmeunieri,* as they all possess the basic features mentioned above.

Polinices hepaticus (Röding, 1798) is another species closely allied to *P. stanislasmeunieri* but differs in that the columellar callus is heavier, more evenly tapering, not truncated, and meets the parietal callus at center or posterior to the center of the apertural opening.

Polinices coronis (Hanna and Isrealsky, 1925), from the Miocene Zorritos Formation of Peru and the Progreso Formation of Ecuador, is a synonym of *P. stanislasmeunieri.* None of the specimens of *P. coronis* examined from either locality are complete, having the anterior canal damaged, however, there is enough of the columellar structure remaining to justify this placement.

Polinices stanislasmeunieri and its allies in the Caribbean and the Tropical East Pacific were widespread during Mio-Pliocene time. Although the group of white

Polinices is represented by more species in the Tropical East Pacific than in the Caribbean; individual species probably arose separately in both regions with *P. stanislasmeunieri* originating in the Caribbean.

Subgenus EUSPIRA Agassiz *in* J. Sowerby, 1838

Euspira AGASSIZ *in* J. SOWERBY, 1838, Min. Conch. Grossbritt., p. 14.

Type species: Natica glaucinoides J. Sowerby, 1812, by subsequent desig., Bucquoy, Dautzenberg and Dollfus, 1883.

POLINICES (EUSPIRA) ELLA (Olsson) Plate 3, figure 5

Natica (Natica) ella OLSSON, 1964, Neogene Moll. Northwest. Ecuador, p. 177, pl. 37, figs. 5, 5a.

Description: Shell small; slightly higher than wide; spire moderately elevated, of about four smooth, somewhat shouldered whorls, early whorls eroded; suture appressed to slightly impressed; sculpture of short retractive grooves on early post-nuclear whorls; body whorl convex with faint growth lines; parietal callus thin; umbilicus open, funicular rib reduced to a slight swelling on the columellar callus.

Holotype: USNM 643884.

Type locality: Esmeraldas beds, Punta Gorda, Ecuador.

Occurrence: Esmeraldas beds, Ecuador.

Discussion: When Olsson (1964, p. 177) described *P. ella* he placed it in the genus *Natica* on the basis of a funicular rib, however *P. ella* does not have a true funicular rib but rather a slight swelling.

Polinices ella is similar to the Recent *P. crawfordianus* Dall, 1908, from the Tropical East Pacific. *Polinices crawfordianus* usually has the apex eroded (*fide* Marincovich, 1977, p. 292), as is also the case in the apex of *P. ella*. This condition probably occurs only in the adult form and is a common occurrence is several species. *Polinices crawfordianus* differs mainly in being not as globose, and having an arcuate columella.

A similar species, *P. pallidus* Broderip and Sowerby, 1829, which is circumboreal, reaching south to California in the Pacific and North Carolina in the Atlantic, is variable in outline. The spire is moderately elevated, the whorls are slightly flattened below the suture, and the axial sculpture is of incremental growth lines. In view of the similarities of *P. crawfordianus* and *P. pallidus* to *P. ella* it is appropriate to place *P. ella* in the genus *Polinices*. With the resemblences to the above mentioned species and no apparent relatives in the Caribbean region; *P. ella* probably arose in the Tropical East Pacific.

Genus NEVERITA Risso, 1826

Neverita Risso, 1826, Hist. Natur. Nice et des Alpes Maritimes, v. 4, p. 149.

Type species: Neverita josephinia Risso, 1826, by monotypy.

Subgenus GLOSSAULAX Pilsbry, 1929

Glossaulax PILSBRY, 1929, Nautilus, v. 42, no. 4, p, 113.

Type species: Natica reclusiana Deshayes, 1839, by original desig.

NEVERITA (GLOSSAULAX) RECLUSIANA (Deshayes) Plate 3, figures 6-8

Natica reclusiana DESHAYES, 1839, Rev. Zool. Soc. Cuvier, v. 2, p. 361.

Polinices (Neverita) reclusianus (Deshayes). GRANT and GALE, 1931, San Diego Soc. Nat. Hist., Mem. 1, p. 800, text-figs. 13a-13c; KEEN, 1971, Sea Shells Trop. West Amer., ed. 2, p. 482, fig. 888.

Neverita reclusiana (Deshayes). WOODRING, STEWART, and RICHARDS, 1940, U.S. Geol. Surv., Prof. Paper 195, p. 86 [in part], pl. 20, figs. 1, 3, 5 [not pl. 15, figs. 19, 20, pl. 20, figs. 2, 4, = *N. (G.) andersoni* (Clark, 1918), *fide* Marincovich (1977, p. 317)]; WOODRING and BRAMLETTE, 1950, U.S. Geol. Surv., Prof. Paper 222, p. 73, pl. 20, fig. 4.

Polinices reclusianus (Deshayes). ABBOTT, 1974, Amer. Sea Shells, ed. 2, p. 154, no. 1679.

Neverita (Glossaulax) reclusiana xena WOODRING, 1957, U.S. Geol. Surv., Prof. Paper 306-A, p. 92, pl. 21, figs. 5, 8, 9; OLSSON, 1964, Neogene Moll. Northwest. Ecuador, p. 179.

Neverita (Glossaulax) reclusiana (Deshayes). MARINCOVICH, 1977, Bulls. Amer. Paleontology, v. 70, no. 294, p. 317, pl. 29, figs. 4-12, pl. 30, figs. 1-4, text-fig. 13.

Description: Shell subglobose to elongate; spire low to moderately elevated; suture slightly impressed to appressed; shoulder evenly tapered to distinctly flattened; nuclear whorls smooth, two and one-half turns; post-nuclear whorls about four; sculpture of axial incremental growth lines and microscopic, closely spaced wavy costellae; parietal callus heavy, umbilical

callus moderately open to closed, divided into two lobes by a transverse groove, posterior lobe always largest.

Type material: Three syntypes, Muséum National d'Histoire Naturelle, Paris, France.

Type locality: "Mers de California."

Occurrence: Angostura Formation, Ecuador. Gatun Formation, Panamá; Pliocene. Numerous Eocene to Pleistocene localities from Washington to the Gulf of California. Recent, from northern California and south throughout the Gulf of California.

Discussion: Neverita reclusiana (Deshayes) is an extremely variable species, which in the Recent occurs from northern California to the southern Gulf of California. It apparently arose in the Eocene and at that time was widespread in the eastern Pacific, as well as appearing sparingly in the Caribbean Pliocene. For an extensive discussion of geographic occurrences see Marincovich (1977, p. 319).

In comparing Recent specimens of *N. reclusiana* to *N. reclusiana xena* Woodring (1957, p. 92) noted: "It is remarkably similar to a small form of *N. reclusiana* (Deshayes) found along the outer coast of Baja California and along the Gulf of California. The Gatun neverite in general has a narrower space between the umbilical wall and the anterior callus lobe. Some small Recent shells, however are practically indistinguishable from the fossils. . . . Inasmuch as *N. reclusiana* has a long history in the eastern Pacific going back to the Miocene if not earlier, *N. reclusiana xena* evidently is a migrant from the Pacific." In comparing specimens from the Angostura Formation of Ecuador, the Gatun Formation of Panamá and paratypes of *N. reclusiana xena* (SU 8711, from Woodring, 1957, locality 137, now at CASG 66586) we find that they are indistinguishable from the many forms of Recent specimens. Therefore we place *N. reclusiana xena* Woodring in synonomy with *N. reclusiana* (Deshayes). It is noteworthy that we have not found *N. reclusiana* in the Pliocene Esmeraldas beds, which indicates that it became extinct in the Caribbean region and the southern end of its range in the Pacific by Pliocene time.

Olsson (1942a, p. 21) in his faunal list from Río Blanco, Charco Azul Formation,

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PLATE 3

Figures

1-4. *Polinices (Polinices) stanislasmeunieri* Maury 120
1. CASG 66582; height 39.2 mm, diameter 31.7 mm (X 1).
Locality: TU 589, Costa Rica; Río Banano Formation.
2. CASG 1716 (holotype-*P. coronis* Hanna and Israelsky); height 31.3 mm, diameter 24.6 mm (X 1.3).
Locality: CAS 328, Peru; Zorritos Formation.
3. PRI 33122; height 24.7 mm, diameter 17.1 mm (X 1.6).
Locality: IPC 508, Ecuador; Progreso Formation.
4. CASG 66583; height 22.6 mm, diameter 17.8 mm (X 1.8).
Locality: CAS 339, Peru; Zorritos Formation.
5. *Polinices (Euspira) ella* (Olsson) 123
CASG 66584 (topotype); height 12.4 mm, diameter 11.4 mm (X 3).
Locality: P-99, Ecuador; Esmeraldas beds.
6-8. *Neverita (Glossaulax) reclusiana* (Deshayes) 123
6. CASG 66585; height 30.0 mm, diameter 29.8 mm (X 1.4).
Locality: P-105, Ecuador; Angostura Formation.
7. CASG 66586; height 27.4 mm, diameter 30.1 mm (X 1.5).
Locality: P-97, Panamá; Gatun Formation.
8. CASG 66587 (paratype-*Neverita (Glossaulax) reclusiana xena* Woodring); height 27.9 mm, diameter 18.8 mm (X 1.9).
Locality: Panamá; Gatun Formation.
9-10. *Neverita (Glossaulax) pabloensis* (Clark) 126
9. CASG 66588; height 27.2 mm, diameter 28.3 mm (X 1.4).
Locality: CAS 65, California; Round Mountain Silt.
10. CASG 66589; height 25.4 mm, diameter 25.8 mm (X 1.8).
Locality: P-103, Ecuador; Angostura Formation.

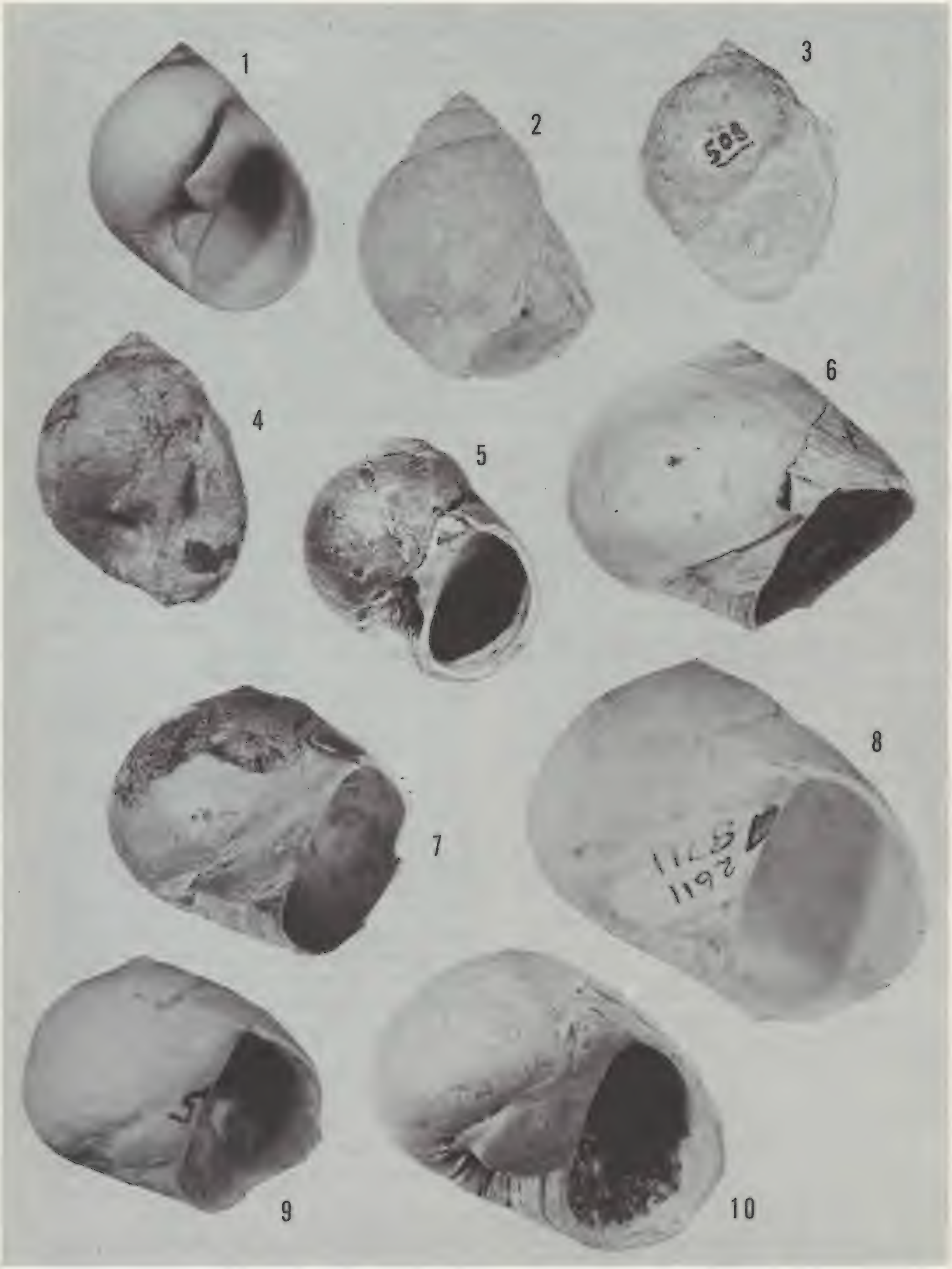

PLATE 3

(Pleistocene) Burica Peninsula of Panamá lists *P.* aff. *reclusiana* (Deshayes), which seems to indicate a gradual extinction northward in the Pacific during the late Pliocene and Pleistocene. We were unable to locate Olsson's specimen of *P.* aff. *reclusiana* from the Burica Peninsula of Panamá in the collections at PRI. Although *N. reclusiana* occurs in several Miocene localities in Ecuador (P-105, P-106, P-107 and between Mompiche-Portete, *fide* Olsson, 1964, p. 179) it is not known from the Esmeraldas beds or other Pliocene localities in Ecuador.

In comparing *N. reclusiana* to other related species we find that the Caribbean *N. subporcana* (Williston, 1927, *ex* Hodson, Hodson, and Harris, MS) is close morphologically except that the umbilical callus is somewhat bulbous. Williston noted that it is close to *N. porcana* (Spieker, 1922) from the Zorritos Formation of Peru. These could prove to be no more than ecological varients of a highly variable species. Majima (1989, p. 53), in discussing the fossil Naticidae of Japan, compared *N. (Glossaulax) didyma didyma* (Röding, 1798) to *N. reclusiana* and noted that with all the variations within the species taken into consideration the two are equal except that at one end of the range of variability within the species there is enough difference to warrant retaining the name *N. didyma didyma.* Taking into consideration the above mentioned differences in just these few species one could make the point that there is but one world-wide species in this highly variable group. This would probably create more problems than we already have and serve no worthwhile purpose.

Neverita reclusiana is more widespread, and goes back farther in the Pacific than in the Caribbean. It probably arose in the Pacific.

Neverita (Glossaulax) pabloensis (Clark)

Plate 3, figures 9, 10; Plate 4, figures 1, 2

Natica (Neverita) pabloensis CLARK, 1915, Univ. Calif. Publs., Bull. Dept. Geol., v. 8, no. 22, p. 488, pl. 68, figs. 12, 14; MARINCOVICH, 1977, Bulls. Amer. Paleontology, v. 70, no. 294, p. 329.

Natica (Neverita) recluziana andersoni CLARK, 1918, Univ. Calif. Publs., Bull. Dept. Geol., v. 11, no. 2, p. 168, pl. 20, figs. 3, 10-12 [not *Natica anderssoni* Strebel, 1906, Zool. Jahr. Syst., v. 24, p. 142, pl. 11, figs. 67, 67a, 67b; Recent, Magellanic region].

Natica pabloensis Clark. TRASK, 1922, Univ. Calif. Geol. Sci., Bull., v. 13, no. 5, p. 143.

Natica andersoni Clark. HANNA, 1924, Calif. Acad. Sci., Proc., (ser. 4) v. 13, no. 10, p. 173.

Polinices reclusianus pabloensis (Clark). CLARK, 1929, Strat. and faunal horiz. of the Coast Range, California, pl. 34, fig. 12; GRANT and GALE, 1931, San Diego Soc. Nat. Hist., Mem. 1, p. 802.

Polinices (Neverita) reclusiana andersoni (Clark). GRANT and GALE, 1931, San Diego Soc. Nat. Hist., Mem. 1, p. 802.

Neverita (Glossaulax) andersoni (Clark). ADDICOTT, 1970, U.S. Geol. Surv., Prof. Paper 642, p. 67, pl. 5, figs. 22-24; MARINCOVICH, 1977, Bulls. Amer. Paleontology, v. 70, no. 294, p. 328, pl. 30, figs. 5-8.

Description: Shell large; slightly wider than high; whorls three, plus protoconch; spire low, body whorl large, inflated, sides somewhat flattened giving appearance of being shouldered; aperture semi-lunar; parietal callus heavy; umbilical callus large, divided by a transverse groove, posterior lobe larger, umbilicus partially open to completely closed.

Holotype: UCMP 11592.

Type locality: UCMP 1227, Contra Costa County, California.

Occurrence: Angostura Formation, Ecuador. Central and southern California; Miocene. Gatun Formation, Panamá; Pliocene.

Discussion: Marincovich (1977, p. 328) gives full species rank to *N. Neverita andersoni* (Clark, 1918) and inadvertently placed *N. pabloensis* (Clark, 1915) in synonomy; therefore, *N. pabloensis* now becomes the taxon of priority. *Neverita pabloensis* (Clark) is most similar to *N. reclusiana* (Deshayes); *N. pabloensis* previously has not been known to occur south of southern California. This seemingly disjunct range throughout its geologic history could be due to a lack of fossil record in this area or an artifact of collecting.

In comparing *N. reclusiana* to *N. andersoni* (Clark), it is noted by Marincovich (1977, p. 331): "When typically developed, as are the great majority of specimens, *N. (G). andersoni* is characterized by a body whorl with flattened sides and tabulate shoulder, massive callus thickly filling the umbilicus, and low spire." Marincovich also noted that, although there are consistant morphologic differences, the two spe-

cies do occur together but do not intergrade at a single locality, however, some specimens are difficult to assign to one species or the other. Marincovich (1977, pl. 30, fig. 5) figured what is supposed to be the holotype of *N. reclusiana andersoni* (UCMP 11212, loc. no. 1131; height 15.3 mm), but Clark (1918, P. 168) cited the height of the type specimen as about 32 mm. The holotype, as described by Clark, is not the specimen placed in the type collection.

There are several lots of *N. pabloensis* from locality CAS 65, Barker Ranch, Kern County, California containing numerous specimens, indentified by Marincovich. In examining these it can be seen that there is considerable variation within the species, in spire height, and shape of body whorl. The spire is always low; the body whorl is straight sided, or nearly so. The size and shape of the umbilical callus, the degree to which it covers the umbilicus is highly variable, as is also the case with *N. reclusiana.* These specimens compare favorably with the specimens from Palestina, Ecuador (P-105). Specimens of *N. pabloensis* from Ecuador are flat sided to somewhat rounded; the shoulders are tabulate, or nearly so and the spires are low, as in the typical *N. pabloensis.* Clark (1918, p. 168) in discussing his *N. andersoni* noted: "The callus is very similar to that seen on *N. recluziana* Petit, of which this form is described as a subspecies, and is just as variable; on some specimens the umbilicus is open anterior to the callus, while on others the callus covers the entire umbilical area." Marincovich (1977, p. 331) adds that the umbilical callus in *N. andersoni,* when typically developed, is massive, thickly filling the umbilicus, with a deep pit at the anterior margin. We have only one specimen that truly meets this criterion (P-105). One specimen (P-129) has the umbilicus slightly open. Of a dozen specimens identified as *N. reclusiana* from the Gatun Formation, Panamá (P-97) there are a few that have the straight sides and somewhat flat spires, enough to place *N. pabloensis* in the Gatun Formation.

Neverita reclusiana differs from *N. pabloensis* mainly in a spire height that is highly variable rather than consistantly low and somewhat flattened. The body is more evenly rounded. The umbilical callus of both species is variable and can completely cover the umbilicus or leave it partly open. Related Caribbean and eastern Pacific fossil species are discussed under *N. reclusiana.*

Neverita andersoni (Clark) (figured by Marincovich, 1977, pl. 30, fig. 8) from the Miocene Topanga Formation, Los Angeles County, California, is a straight sided but high spired form of *N. pabloensis.* No low spired forms are known to occur in the Topanga Formation and, as some forms of *N. reclusiana* are somewhat straight sided but do not have the low spire and shouldered spire, this may prove to be *N. reclusiana.*

We do not have enough specimens of *N. reclusiana* or *N. pabloensis* from Panamá and Ecuador to verify if the two species intergrade. Until more specimens become available for study we will accept the conclusions of previous studies done in California (*fide* Addicott, 1970, p. 67; Marincovich, 1977, p. 328) and report *N. pabloensis* as a valid species occurring in Panamá and Ecuador.

Subfamily SININAE Wenz, 1941
Genus SINUM Röding, 1798

Sinum Röding, 1798, Mus. Bolten., pt. 2, p. 14.

Type species: Helix haliotoidea Linnaeus, 1758, by subsequent desig., Dall, 1915.

SINUM LACONDAMINI
Olsson
Plate 4, figure 3

Sinum lacondamini OLSSON, 1964, Neogene Moll. Northwest Ecuador, p. 183, pl. 37, figs. 4, 4a.

Description: Shell globose; spire low to moderately elevated; whorls rounded; suture distinct to slightly impressed; spiral sculpture of flat topped bands separated by interspaces of about equal width, with one or more secondary bands between; axial sculpture of incremental growth lines, at times giving spiral bands a slightly wavy appearance; parietal callus thin; umbilicus open, slitlike; umbilical callus narrow, flattened, overlapping and partially concealing umbilicus.

Holotype: USNM 644120.

Type locality: Esmeraldas beds, Punta Gorda, Ecuador.

Occurrence: Esmeraldas beds, Ecuador.

Discussion: Comparison of *S. lacondamini* Olsson to Caribbean fossil specimens of *S. gabbi* (Brown and Pilsbry, 1913),

shows the latter is very close in most morphological details, except that the aperture is larger and flares outwardly to a much greater degree. Olsson (1964, p. 183) compared *S. lacondamini* to *S. imperforatum* Dall, 1915, but Dall's species is taller, the aperture is nearly round, and the spiral threads are minutely zigzagged by incremental growth lines. In another related species, *S. waltonense* Gardner (1947), the surface is covered by fine and crowded lirae, minutely crinkled by the incrementals, equal to the zigzag spirals of *S. imperforatum*. These two species are similar in general morphology and are the closest species morphologically.

In the Recent fauna of the Tropical East Pacific *S. grayi* (Deshayes, 1843) is similar to *S. lacondamini* in that the apertures are about the same shape, except that the anterior portion from the columella to the outer portion in *S. lacondamini* is straight, rather than curved, which leaves the outermost part almost truncated.

All of the above mentioned species are part of a closely allied group and most probably arose from the same stock. Woodring (1957, p. 94), in his discussion of *S. gabbi*, noted that no similar species are living today in the Caribbean. The fossil record of this group in the Tropical East Pacific is not known to go as far back as it does in the Caribbean, leaving the probability that these related species arose in the Caribbean.

SINUM sp. cf. S. CYMBA (Menke)
Plate 4, figure 4

Sigaretus cymba MENKE, 1828, Synopsis Methodica Molluscorum Museo Menkeano, p. 88.

Sigaretus concavus Lamarck. BURCH and BURCH, 1964, Nautilus, v. 77, no. 4, p. 109, pl. 5, figs. 2, 4, [not *S. concavus* (Lamarck, 1822)].

Sinum cymba (Menke). KEEN, 1971, Sea Shells Trop. West Amer., ed. 2, p. 482, fig. 889; MARINCOVICH, 1977, Bulls, Amer. Paleontology, v. 70, no. 294, p. 343, pl. 32, figs. 1-6,

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PLATE 4

Figures

Page
1-2. *Neverita (Glossaulax) pabloensis* (Clark) 126
1. CASG 66590; height 29.3 mm, diameter 30.8 mm (X 1.3).
Locality: P-105, Ecuador; Angostura Formation.
2. CASG 66591; height 28.7 mm, diameter 31.1 mm (X 1.4).
Locality: P-97, Panamá; Gatun Formation.
3. *Sinum lacondamini* Olsson 127
CASG 66593; height 18.7 mm, diameter 17.2 mm (X 2.4).
Locality: P-101, Ecuador; Esmeraldas beds.
4. *Sinum* sp. cf. *S. cymba* (Menke) 128
CASG 66594; height 16.9 mm, diameter 19.5 mm (X 2.2).
Locality: P-101, Ecuador; Esmeraldas beds.
5-7. *Natica (Natica) inexpectans* Olsson 130
5. CASG 66552; height 19.2 mm, diameter 20.0 (X 1.7).
Locality: P-100, Ecuador; Esmeraldas beds.
6. CASG 66553; height 15.2 mm, diameter 15.6 mm (X 2.3).
Locality: P-100, Ecuador; Esmeraldas beds.
(Color pattern as shown by ultra-violet light).
7. USNM 701161 (holotype); height 23.1 mm, diameter 22.6 mm (X 1.6) (from Olsson, 1971).
7a, operculum; length 15 mm; width 10.4 mm (X 1.7).
Locality: Panamá Bay, Panamá; Recent.
8-10. *Natica (Naticarius) scethra* Dall 130
8. CASG 66554; height 23.7 mm, diameter 20.8 mm (X 1.8).
Locality: P-101, Ecuador; Esmeraldas beds.
9. CASG 66555; height 29.0 mm, diameter 27.1 mm (X 1.4).
Locality: P-101, Ecuador; Esmeraldas beds.
10. LACM 66-130.3; height 27.2 mm, diameter 26.0 mm (X 1.4).
Locality: Paita, Peru; Recent.

PLATE 4

text-fig. 11d.

Description: Spire low to moderately elevated; suture slightly impressed; spiral sculpture of fine, flat-topped bands with narrower interspaces; axial sculpture of incremental growth lines, disrupting the spirals and giving them a wavy appearance; aperture ovate, flaring, oblique, pointed anteriorly; parietal callus thin; umbilicus open, slitlike; umbilical callus flattened, partially concealing umbilicus.

Type material: Unknown, presumably sold to a dealer and lost (Zilch, 1958, p. 53).

Type locality: "Oceano Peruviana."

Occurrence: Esmeraldas beds, Ecuador.

Discussion: Sinum cymba (Menke) differs from *S. grayi* (Deshayes) by having a lower spire, a more widely flaring aperture, and a body whorl that is somewhat flattened anteriorly. We hesitate to refer our specimen to *S. cymba* except with "cf.," as our single specimen has all of the columella missing.

Subfamily NATICINAE Forbes, 1838
Genus NATICA Scopoli, 1777

Natica SCOPOLI, 1777, Introductio ad Historiam Naturalem, p. 392.

Type species: Nerita vitellus Linnaeus, 1758, by subsequent desig., Anton, 1839.

Subgenus NATICA s.s.
NATICA (NATICA) INEXPECTANS Olsson
Plate 4, figures 5-7

Natica (Naticarius) cf. *scethra* Dall. OLSSON, 1964, Neogene Moll. Northwest. Ecuador, p. 178, pl. 32, figs. 9-9c [not *Natica (Cochlis) scethra* Dall, 1908].

Natica inexpectans OLSSON, 1971, Bull. Mar. Sci., v. 21, no. 1, p. 69, figs. 31a, 31b, 32.

Natica (Natica) inexpectans Olsson. KEEN, 1971, Sea Shells Trop. West Amer., ed. 2, p. 475, no. 864a; MARINCOVICH, 1977, Bulls. Amer. Paleontology, v. 70, no. 294, p. 370, pl. 36, figs. 6, 7.

Description: Shell small, of about four whorls; suture distinct; spire low or of medium height; whorls smooth except for incremental growth lines; body whorl large, globose; umbilicus open, deep; funicular rib small or lacking.

Holotype: USNM 701161.

Type locality: R/V *John Elliot Pillsbury* locality P-513, Gulf of Panamá ENE of Cabo Mala (7° 39.5' N, 79° 40.7' W, depth 117 meters).

Occurrence: Esmeraldas beds, Ecuador. Recent, Gulf of Panamá.

Discussion: In comparing specimens of *N. inexpectans* Olsson, from Quebrada Camarones, to *N. inexpectans* from the Recent fauna, as described by Olsson (1971, p. 69), we find that the only difference is in the height of the spire, which is generally higher in specimens from Quebrada Camarones, otherwise they are morphologically equal. Under ultra-violet light the specimens from Quebrada Camarones (pl. 4, fig. 6) show the same color pattern as Recent specimens, with widely spaced axial lines from the suture to the base. Specimens of *Natica* cf. *scethra* Dall of Olsson (1964, p. 178, pl. 32, figs. 9, 9a, USNM 645250; 9b, USNM 643887) do not fluoresce. Not all specimens of a single species from one locality will fluoresce and we were not able to treat the specimens at the USNM with sodium hypochlorite, which is often necessary to bring out the color pattern. In view of these data we consider *N.* cf. *scethra* Dall of Olsson, 1964, to be a synonym of *N. inexpectans* Olsson, 1971.

Natica inexpectans Olsson is similar to *N. brunneolinea* McLean, 1970, from the Galápagos Islands, Ecuador, except that the latter species is generally larger; the color pattern is of axial lines that are more closely spaced than in *N. inexpectens,* and the axials do not extend to the base of the shell. Marincovich (1977, p. 385), discussing *N. brunneolinea,* noted: "This species is most similar to *N. scethra* Dall, 1908 and the opercula of the two species are indistinguishable." *Natica scethra* is morphologically similar but lacks the axial stripes of *N. brunneolinea.* It is probable that all of these species came from a common ancestor and originated in the Tropical East Pacific.

Subgenus NATICARIUS Duméril, 1806

Naticarius DUMÉRIL, 1806, Zoologie Analytique, p. 164.

Type species: Natica canrena Linnaeus, 1758, by subsequent desig., Froriep, 1806.

NATICA (NATICARIUS) SCETHRA Dall
Plate 4, figures 8-10

Natica (Natica) scethra DALL, 1908, Harvard Mus. Comp. Zool., Bull., v. 43, no. 6, p. 333, pl. 11, fig. 5.

Natica (Naticarius) othella burica OLSSON, 1964, Neogene Moll. Northwest. Ecuador, p.

178, pl. 32, figs. 5-5c.

Natica (Natica) scethra Dall. KEEN, 1971, Sea Shells Trop. West Amer., ed. 2, p. 475, fig. 866.

Natica (Naticarius) scethra Dall. MARINCOVICH, 1977, Bulls. Amer. Paleontology, v. 70, no. 294, p. 382, pl. 37, figs. 7, 8.

Description: Shell of medium size, thin, spire moderately elevated; suture distinct; axial sculpture of retractive grooves from suture to about one-half distance to periphery, weaker on later whorls; body whorl inflated, evenly rounded; aperture ovate to semicircular; parietal callus thin, ending with a small notch posteriorly; umbilicus narrowly open, with small, flat funicular rib fused to columellar callus.

Holotype: USNM 123048.

Type locality: R/V *Albatross* station 3391, Gulf of Panamá, 153 fms [280 meters].

Occurrence: Esmeraldas beds, Ecuador. Burica Peninsula, Panamá; Pleistocene. Recent, Mexico to Ecuador and the Galápagos Islands.

Discussion: Natica scethra Dall, resembles the Tropical East Pacific species *N. othello* Dall, which has a higher spire, and is not as globose; the umbilical sulcus is not as narrow and the posterior notch on the umbilical callus is deeper. The Recent *N. caneloensis* Hertlein and Strong (1955) is very close in form, differing mainly in having a wider umbilical sulcus, and a different color pattern. In discussing differences between *N. scethra* and *N. caneloensis,* Marincovich (1977, p. 383) noted that these species probably could not be separated if preserved as fossils, lacking color pattern and opercula. Numerous lots of *N. scethra* examined at LACM show considerable variation within the species.

In comparing specimens of *N. othella burica* Olsson (1964, p. 178) to *N. othello* Dall (1908, p. 332) and *N. scethra* Dall (1908, p. 333) we find that specimens from the Esmeraldas beds are not as high spired, they are more globose and have a more narrow umbilical opening than the typical *N. othello.* Most specimens do have a small *sulcal* notch as in *N. othello* (Marincovich, 1977, pl. 37, fig. 1). *Natica scethra* (*ibid.*, pl. 37, fig. 8) shows the typical *N. scethra* with the narrow umbilical opening, but pl. 37, fig. 7 shows a specimen with a slight notch in the umbilical callus. *Natica othello* (Marincovich, 1977, pl. 35, fig. 11) is morphologically equal to *N. scethra.* The color pattern of the two species is slightly different and they are most difficult to separate in the fossil record.

Olsson (1942a, p. 231), in discussing *N. scethra burica* (pl. 5, figs. 1, 1a), noted that the operculum of this subspecies has two marginal ribs with the outer one being smaller, whereas Dall's figure of *N. scethra* shows the ribs being of nearly equal size. From Recent specimens examined we find that the ribs are not always of equal size. Olsson (1964, p. 178) placed his subspecies *N. scethra burica* Olsson, 1942, in synonomy with his new subspecies *N. othella burica* Olsson, 1964. The holotype of *N. scethra burica* Olsson (1942a, p. 231(79), pl. 10, figs. 2, 7) has a more open umbilicus than the typical *N. scethra* and is more like *N. othello* Dall; however, *N. othello* has an operculum with two narrow marginal ribs, both being pustulate. The operculum of *N. scethra burica* is the same as the operculum of *N. scethra. Natica scethra burica* has a raised rib just posterior to the umbilicus. *Natica othella burica* Olsson, 1964, does not have the raised rib adjacent to the umbilicus and we have not seen an operculum equal to the operculum of *N. scethra burica* in the Esmeraldas beds. For the above reasons we consider *N. othella burica* a synonym of *N. scethra* and reinstate *N. scethra burica* as a valid subspecies of *N. scethra.*

Natica scethra does not appear to have any close relatives in the Caribbean region and probably arose in the Pacific.

Subgenus STIGMAULAX Mörch, 1852

Stigmaulax Mörch, 1852, Cat. Conch. Yoldi, fasc. 1, p. 133.

Type species: Nerita sulcata Born, 1778, by subsequent desig., Harris, 1897.

Natica (Stigmaulax) broderipiana Récluz

Plate 5, figures 2, 3

Natica broderipiana RÉCLUZ, 1844, Zool. Soc. London, Proc. (1843), v. 11, p. 205; DALL, 1909, U.S. Natl. Mus. Proc., v. 37, no. 1704, p. 235; PILSBRY and OLSSON, 1941, Acad. Nat. Sci. Phila., Proc., v. 93, p. 8, 45; OLSSON, 1942, Bulls. Amer. Paleontology, v. 27, no. 106, p. 163(11), 169(17), 170(18), 173(21).

Natica (Stigmaulax) broderipiana Récluz. KEEN, 1971, Sea Shells Trop. West Amer.,

ed. 2, p. 477, fig. 870; MARINCOVICH, 1977, Bulls. Amer. Paleontology, v. 70, no. 294, p. 399, pl. 40, figs. 6, 7.

Stigmaulax broderipiana (Récluz). OLSSON, 1964, Neogene Moll. Northwest. Ecuador, p. 181, pl. 32, figs. 1-1b; ABBOTT, 1974, Amer. Sea Shells, ed. 2, p. 160, no. 1728.

Description: Medium size; spire moderately high to high; whorls about five; suture impressed; body whorl inflated, evenly rounded; sculpture of fine axial grooves from suture to umbilicus, strongest from suture to periphery of body whorl where they become indistinct; aperture large, parietal callus fairly heavy; columellar wall curved; umbilicus opening large, bordered anteriorly by a sulcus; umbilical callus large, broad, semicircular, with concave anterior portion; funicular rib large, filling anterior half of umbilicus.

Holotype: No. 1350/51, Muséum d'Histoire Naturelle, Geneva, Switzerland.

Type locality: "Xipixapi, West Colombia" [Jipijapa, Ecuador], 29 meters, sandy mud (Récluz, 1844).

Occurrence: Esmeraldas beds, Canoa Formation, Ecuador. Magdalena Bay, Baja California and the Tres María Islands, Mexico; Burica Peninsula, Panamá; Pleistocene. Recent from Cabo San Lucas, Baja California, Mexico, throughout the Gulf of California and south to Ecuador.

Discussion: In comparing *N. broderipiana* from the Esmeraldas beds to *N. guppiana* Toula, 1909, it may be seen that *N. guppiana* differs in having axial grooves in adult shells that do not generally extend below the periphery; the suture is more deeply impressed; there is a small secondary rib adjacent to the funicular rib. Some specimens of *N. broderipiana* show indications of swelling on the columella where the secondary rib of *N. guppiana* occurs. The opercula are similar except that the central rib is wider in *N. guppiana*. The color pattern is similar, but in *N. broderipiana* the markings are square

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PLATE 5

Figures Page

1. *Natica (Naticarius) scethra burica* Olsson 131
PRI 4068 (holotype); height 27.5 mm, diameter 27.0 mm (X 1.3).
1a, operculum; height 21.0 mm, diameter 12.0 mm (X 1.3).
Locality: Panamá; Charco Azul Formation.

2-3. *Natica (Stigmaulax) broderipiana* Récluz 131
2. CASG 66556; height 36.0 mm, diameter 34.8 mm (X 1.3).
Locality: P-101, Ecuador; Esmeraldas beds.
3. CASG 66557; height 42.2 mm, diameter 40.9 mm (X 1).
Locality: P-101, Ecuador; Esmeraldas beds.
(Color pattern as shown by ultra-violet light).

4-9. *Natica (Stigmaulax) guppiana* Toula 134
4. CASG 66558; height 19.2 mm, diameter 19.0 mm (X 2).
Locality: TU 1429, Panamá; Gatun Formation.
5. CASG 66559; height 18.1 mm, diameter 16.2 mm (X 2).
Locality: P-95, Panamá; Gatun Formation.
(Color pattern as shown by ultra-violet light).
6. CASG 66560; height 24.0 mm, diameter 23.7 mm (X 1.9).
Locality: P-95, Panamá; Gatun Formation.
7. CASG 66561; height 16.5 mm, diameter 15.1 mm (X 2.3).
Locality: P-103, Ecuador; Angostura Formation.
8. CASG 66562; height 13.7 mm, diameter 13.4 mm (X 2.5).
8a, Color pattern as shown by ultra-violet light (X 2.7).
Locality: P-125, Ecuador; Cachabí Formation.
9. CASG 66563; height 19.7 mm, diameter 17.1 mm (X 2).
Locality: P-102, Ecuador; Angostura Formation.

10. *Natica (Stigmaulax) landesiana* Olsson 135
CASG 66564 (topotype); height 11.7 mm, diameter 11.7 mm (X 3.3).
Locality: P-100, Ecuador; Esmeraldas beds.

11. *Naticid operculum* 136
CASG 66592; length 9.3 mm, width 5.9 mm (X 3.9).
Locality: P-101, Ecuador; Esmeraldas beds.

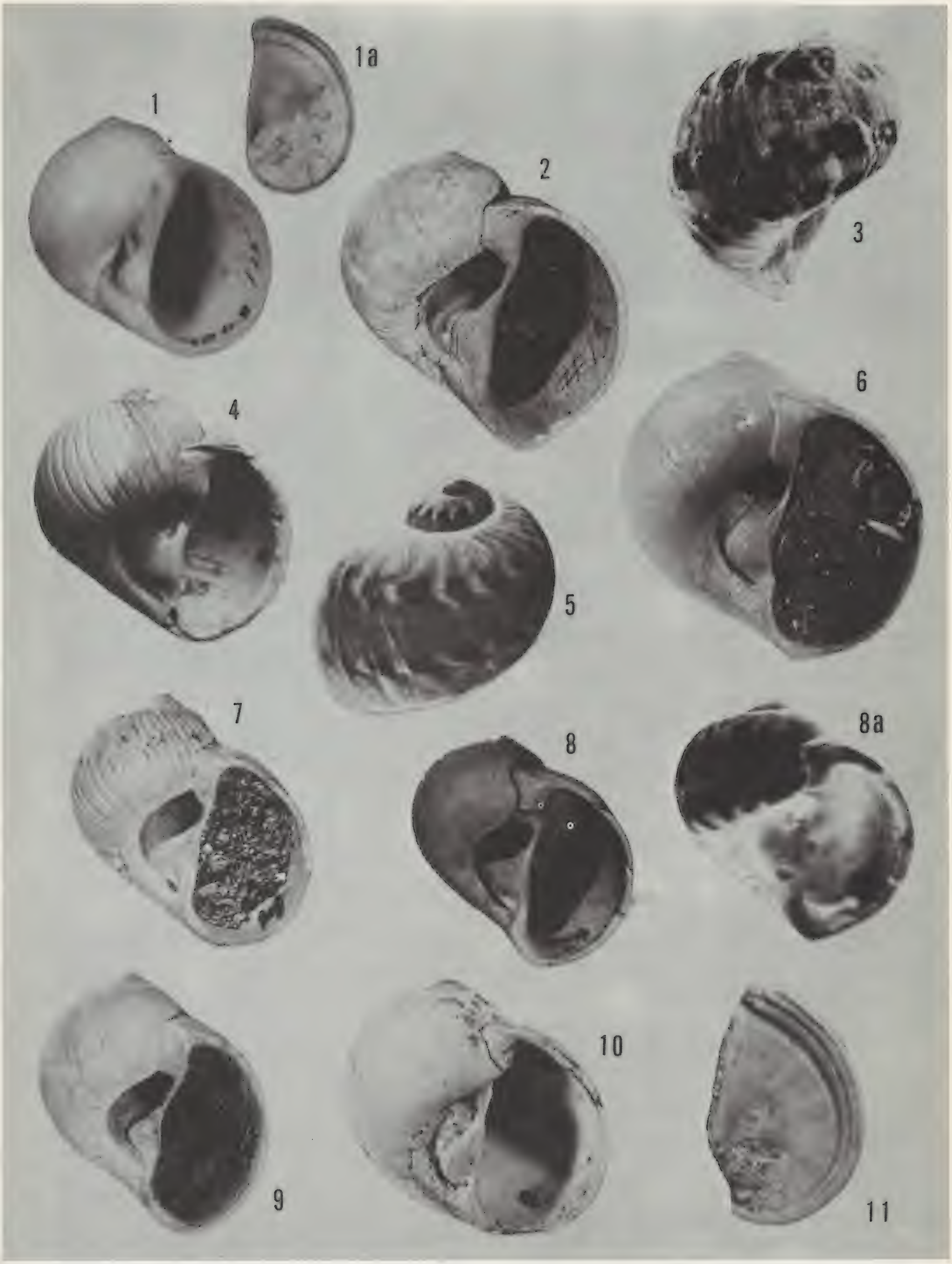

PLATE 5

rather than chevron shaped as in *N. guppiana.*

Natica sulcata Born, 1778, another related Recent species from the Atlantic, differs in having the axial grooves of equal strength from suture to umbilicus; the suture is more deeply impressed. The color pattern varies from white with brown blotches to pure white and is smaller than either *N. guppiana* or *N. broderipiana.* Marincovich (1977 p. 400) noted that the suture of *N. broderipiana* is strongly impressed; however, some Recent specimens examined have the suture only slightly impressed or appressed. Woodring (1957, p. 87) noted: "Forms of *Stigmaulax* closely related to the Recent Caribbean *S. sulcata* (Born) are found in formations of Jamaica, Haiti, the Dominican Republic, Puerto Rico, and Brazil. *S. guppiana,* however, is not one of them. It lacks gross spiral sculpture and is more closely allied to the Recent Panamic *S. broderipiana* (Récluz), as pointed out by Olsson (1932, p. 207)."

Natica elenae Récluz, 1844, another related species, from the Tropical East Pacific Recent, differs in having a color pattern of fine axial lines. The axial grooves become indistinct from the periphery to the umbilicus. The operculum differs in having a heavy secondary spiral rib anteriorly, rather than several low spiral ribs; otherwise the two species are very close morphologically.

The oldest known record of *N. broderipiana* in the eastern Pacific is in the Esmeraldas beds of Ecuador. The difference between *N. broderipiana* and *N. guppiana* lies in the color pattern and the secondary funicular rib, or lack of same. *Natica broderipiana* probably arose in the Pacific from *N. guppiana* stock.

NATICA (STIGMAULAX) GUPPIANA
Toula
Plate 5, figures 4-9

Natica guppiana TOULA, 1909, Geol. Reichs. Jahrb., v. 58, p. 696, pl. 25, fig. 6; HODSON, HODSON, and HARRIS, 1927, Bulls. Amer. Paleontology, v. 13, no. 49, p. 67, pl. 36, figs. 1, 4.

Natica guppyana [*sic*] Toula. OLSSON, 1922, Bulls. Amer. Paleontology, v. 9, no. 39, p. 328(156), pl. 13, figs. 13-15; ANDERSON, 1929, Calif. Acad. Sci., Proc., (ser 4) v. 18, no. 4, p. 123.

Natica (Naticarius) guppyana [*sic*] Toula. OINOMIKADO, 1939, Geol. Soc. Japan, Jour., v. 46, p. 621(107), pl. 29(15), fig. 18.

Natica (Stigmaulax) guppiana Toula. GARDNER, 1947, U.S. Geol. Surv., Prof. Paper 142-H, p. 546, pl. 59, fig. 9.

Natica (Stigmaulax) guppiana toulana GARDNER, 1947, U.S. Geol. Surv., Prof. Paper 142-H, p. 547, pl. 59, figs. 7, 8.

Natica (Stigmaulax) guppyana [*sic*] Toula. MARKS, 1951, Bulls. Amer. Paleontology, v. 33, no. 139, p. 368(98).

Stigmaulax guppiana Toula. WOODRING, 1957, U.S. Geol. Surv., Prof. Paper 306-A, p. 86, pl. 20, figs. 11-16; OLSSON, 1964, Neogene Moll. Northwest. Ecuador, p. 181, pl. 37, figs. 2, 2a.

Stigmaulax kugleriana OLSSON, 1964, Neogene Moll. Northwest. Ecuador, p. 181, pl. 37, figs. 3, 3a.

Description: Large; thick shelled; spire low to medium height; suture distinct; whorls about four, inflated, rapidly enlarging; body whorl with well rounded profile; sculpture of relatively widely spaced, retractive grooves, generally ending at or above periphery of body whorl, extending to umbilicus in some shells but not on last half of body whorl on large shells; umbilicus wide with large funicular rib, rapidly enlarging, ending with a moderately wide callus lobe, concave anteriorly, with a deep sulcus on the anterior side of the funicular rib and a small secondary rib posteriorly on most shells; parietal callus thick.

Holotype: Tech. Hochschule, Vienna.

Type locality: Gatun Locks excavation, Canal Zone, Panamá.

Occurrence: Angostura and Cachabí formations, Ecuador. La Vela Formation, Venezuela; Shoal River Formation, Florida; Miocene. Gatun Formation, Panamá; Río Banano Formation, Costa Rica; Pliocene. Tubará Group, Colombia; Plio-Pleistocene.

Discussion: In comparing specimens of *N. guppiana* from Gatun localities along the Transisthmian Highway, between Sabanita and Cativá, San Judas Todeo, and Payardi Island, Panamá (Lower Gatun, Woodring, 1957, p. 125) to the figures of Woodring (1957, pl. 20, figs. 11-18) we find that Woodring's figures show axial grooves over the entire body surface. The specimens figured by Woodring come from the eastern area near the Gatun locks, the third lock cut, and along the Panamá Railroad (Middle Gatun, Woodring, 1957, p. 125, 126). We have more than one hundred specimens from Lower Gatun localities, and find only a few specimens, mostly small, having axial grooves over the entire

surface. The figured specimen (pl. 5, fig. 4, locality TU 1429) is from near Woodring's locality 178 (Upper Gatun) and does have axial grooves over the entire body surface as do Woodring's figured specimens from the Upper Gatun. Olsson (1964, p. 181, pl. 37, figs. 2, USNM 645256, fig. 2a, USNM 643895) figured small poorly preserved specimens of *N. guppiana* from between Mompiche and Portete, Manabí Prov., Ecuador. He also noted that the smaller specimens have axial grooves over the entire body surface.

Comparing *N. guppiana* Toula from the Angostura Formation of Ecuador to specimens from the Gatun Formation of Panamá shows that specimens from Ecuador have the axial grooves more closely spaced and the secondary funicular rib less pronounced than in most Gatun specimens. One specimen from Ecuador has a wide shallow sulcus and a flat face on the umbilical callus lobe rather than the typical deep sulcus and concave face on the callus lobe.

Specimens of *N. guppiana* from localities (P-103, P-129) south of Punta Verde have grooves over the entire body surface with four or five faint axial striations on the axial ribs. Upon close examination of specimens from along the Transistmian Highway (Lower Gatun), Panamá, we find that under the surface glaze of well preserved shells the faint striations on the ribs can be seen.

Barro Colorado, Cachabí Formation, (locality P-125) Río Santiago, Esmeraldas Prov., Ecuador, is morphologically equal to other specimens of *N. guppiana,* however, under ultra-violet light the color pattern is similar to that of typical *N. guppiana* except that it has a central row of arrow shaped marks. This is probably an ecological variant rather than a different species. One specimen is hardly enough evidence to justify a new species based on color pattern, as color patterns can vary from locality to locality in some species.

Weisbord (1962, p. 247) mentioned *N. guppiana* from the Mare Formation, Venezuela, but noted that it was incomplete and he was unable to make a positive identification. Since the Mare Formation is Pleistocene and the specimen is incomplete it is appropriate to disregard this reported possible occurrence.

Natica kugleriana Olsson (1964, p. 182) was described as differing from *N. guppiana* "by its thinner shell; in having the penultimate whorl with a less pronounced bulge and more important in that the axial groovings are restricted to the sutural area at all stages of growth, even the smallest specimens, less than 8 mm in diameter, are sculptured similar to the large ones." Upon examining specimens of *N. guppiana* from Panamá it is noted that USNM 561343 is a thin shelled specimen, USNM 561342 does not have the penultimate whorl as bulbous as most specimens of *N. guppiana.* In view of all the variations in *N. guppiana* we find no reason to retain the name *N. kugleriana* and place this species in synonomy with *N. guppiana.*

NATICA (STIGMAULAX) LANDESIANA (Olsson)

Plate 5, figure 10

Stigmaulax landesiana OLSSON, 1964, Neogene Moll. Northwest. Ecuador, p. 182, pl. 32, figs. 8, 8a.

Description: Shell small; globose; spire low, of about four whorls; body whorl large, profile well rounded, surface smooth except for fine growth lines and a series of retractive grooves extending from the suture to the shoulder of the whorl; umbilicus open with a large funicular rib, wide at base, bounded by a deep sulcus; aperture semi-ovate; outer lip thin.

Holotype: USNM 643898.

Type locality: Esmeraldas beds, Quebrada Camarones, Ecuador.

Occurrence: Esmeraldas beds, Ecuador.

Discussion: Comparing *N. landesiana* (Olsson) to *N. guppiana* Toula shows that the outline of both species is similar, but *N. guppiana* differs in having the axial grooves more widely spaced; the umbilical area is more open; the columellar callus lobe has a depression anteriorly, whereas in *N. landesiana* the callus lobe is flat, and there is a distinct band bordering the umbilicus, which is lacking in *N. guppiana.* Also, *N. guppiana* has a small secondary rib on the posterior side of the funicular rib, which is totally lacking in *N. landesiana.* Upon close examination of the axial ribs there is an indication of faint striations on the ribs, as can be observed in well-preserved specimens of *N. guppiana.*

Several East Pacific species, including *N. landesiana,* are apparently derived from *N. guppiana* and represent the last appearance of the *N. guppiana* complex in the Tropical East Pacific.

NATICID operculum
Plate 5, figure 11

Description: Calcereous; flat; semicircular; outer edge bordered by four smooth, narrow, raised ribs with narrow grooves between, except that the inner groove is wide.

Occurrence: Esmeraldas beds, Ecuador.

Discussion: Olsson (1964, p. 178), in discussing *N.* cf. *scethra* Dall noted that the operculum is unknown, but figured an operculum with no explanation (1964, pl. 32, fig. 9c).

In describing the operculum of *N. scethra,* Marincovich (1977, p. 382) stated "outer surface smooth except for two deep, sharply incised grooves near outer margin that form two undercut ribs, one between the grooves and one along the outer opercular margin. Outermost margin with one minute, weakly pustulate costella."

Olsson (1971, p. 69), noted that the operculum of *N. inexpectans* is bordered by four ribs. We collected one specimen from the Esmeraldas beds (P-100), which has two ribs but shows sign of wear along the outer margin and may have had another rib. The operculum figured by Olsson (1964, pl. 32, fig. 9c) has only two ribs but has a wide groove inside the innermost rib, the same as the operculum that we have, which leaves these belonging to an unknown species, possibly *N. landesiana,* a small species with an unknown operculum.

V. LOCALITY DATA

The following are Pitt localities:

P-95. Gatun Fm., south side of Boyd-Roosevelt Highway, San Judas Todeo housing project, about 2 km north of Cativá, Colón Prov., Panamá.

P-97. Gatun Fm., north side of Boyd-Roosevelt Highway, about 1 km east of junction with road to Puerto Pilon, Sabanita, Colón Prov., Panamá.

P-99. Esmeraldas beds, Punta Gorda (intertidal), about 8 km west of Las Palmas, Esmeraldas Prov., Ecuador.

P-100. Esmeraldas Beds, east bank of Estero Camarones, east of the village of Camarones, about 10 km east of the mouth of Río Esmeraldas, Esmeraldas Prov., Ecuador.

P-101. Esmeraldas Beds, road cut (south side), immediately west of the village of Camarones, about 10 km east of the mouth of Río Esmeraldas, Esmeraldas Prov., Ecuador.

P-102. Angostura Fm., Punta Verde (intertidal), about 2 1/2 km east of the mouth of Río Verde and about 22 km east of the mouth of Río Esmeraldas, Esmeraldas Prov., Ecuador.

P-103. Angostura Fm., sea cliffs about 300 m west of Punta Verde, about 2 1/4 km east of the mouth of the Río Verde and about 22 km east of the mouth of Río Esmeraldas, Esmeraldas Prov., Ecuador.

P-105. Angostura Fm., road cut (south side), at junction of road from Esmeraldas to Río Verde, with road to El Alto in village of Palestina, Esmeraldas Prov., Ecuador.

P-106. Angostura Fm., road cut (west side), about 0.6 km south of Palestina on road to El Alto, about 20 km east of the mouth of Río Esmeraldas, Esmeraldas Prov., Ecuador.

P-107. Angostura Fm., road cut (west side), about 1.5 km south of Palestina, on road to El Alto, about 20 km east of the mouth of Río Esmeraldas, Esmeraldas Prov., Ecuador.

P-125. Cachabí Fm., blocks in river and on the river bank on the outside of the first turn downstream from Barro Colorado, Río Santiago, Esmeraldas Prov., Ecuador.

P-126. Bahía Fm., Punta Mesita, (of recent maps, equals Punta La Colorada of older literature) sea cliffs about 5 km southwest of Bahía de Caráquez, Manabí Prov., Ecuador.

P-129. Angostura Fm., cliff face about 50 m east of P-103, about 2 1/4 km east of the mouth of Río Verde and about 22 km east of the mouth of Río Esmeraldas, Esmeraldas Prov., Ecuador.

The following are Tulane University localities:

60. Jackson Bluff Fm., borrow pits at Jackson Bluff, Ochlockonee River (NW 1/4 Sec. 21, T1S, R4W), Leon Co., Florida.

376. Duplin Fm., "Natural Well," sinkhole on Matthews' farm, on North Carolina Highway 11, 2 miles west of Magnolia, Duplin Co., North Carolina.

589. Río Banano Fm., Río Banano, north bank, about 0.6 to 0.8 km above the railroad bridge at La Bomba, Limón Province, Costa Rica.

1000. "Pinecrest Beds" [now Fruitville Fm.], APAC pits at east end of 17th street about 8 miles east of U.S. Highway 301 [now northwest of Fruitville Rd. exit, I-75] at Sarasota, (T36S, R19E), Sarasota Co., Florida.

1358. Cercado Fm., Río Gurabo, west side and downstream from mouth of Arroyo La Cabra, or about 5.75 km to 6.0 km (airline), above the bridge on the Los Quemados-Sabaneta Road, Dominican Republic.
1377. Cercado Fm., Río Gurabo, west side, about 0.5 km above the mouth of Arroyo La Cabra, or approximately 6.4 km (airline) above the ford on Los Quemados-Sabaneta road, Dominican Republic.
1429. Gatun Fm., 1 km southeast of Boyd-Roosevelt Highway, just south of Coco Solo Hospital, Panamá.
R-185. Farfan Beach, south side of Panamá Canal on road to Palo Seco, Panamá.

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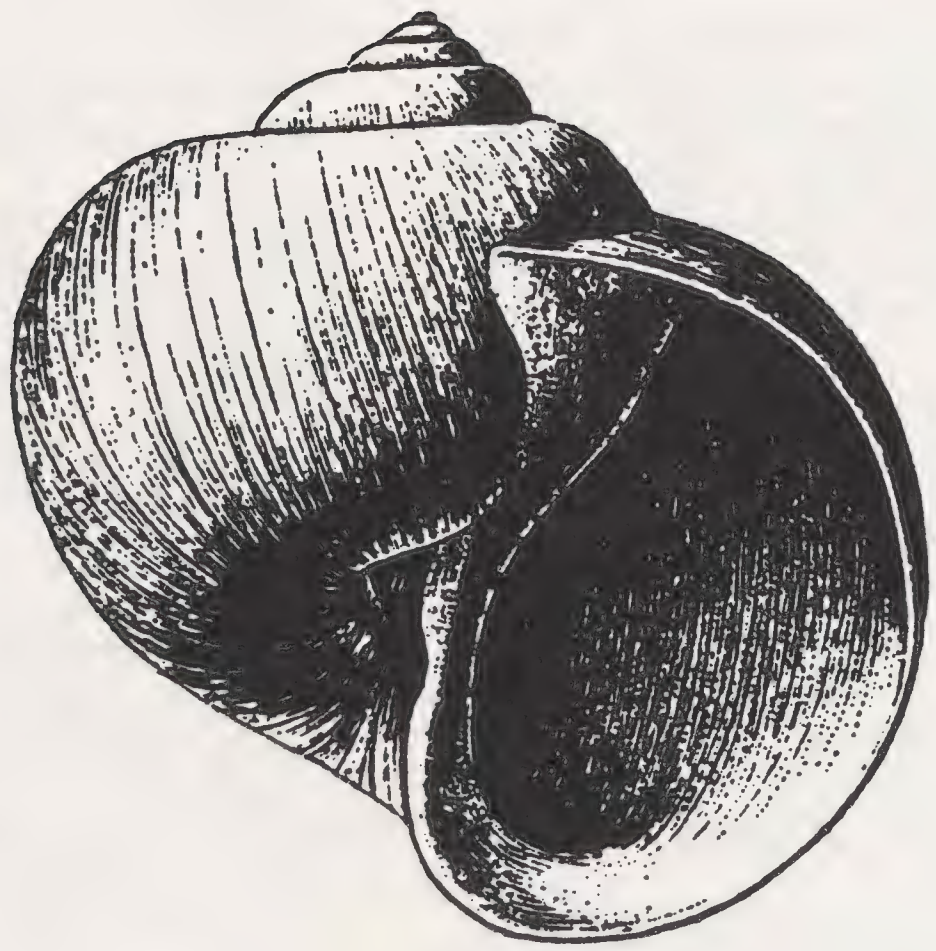

A POTPOURRI OF NEW FORAMINIFERAL GENERA AND SUBGENERA PROPOSED SINCE 1987 (LISTING AND OBSERVATIONS)

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ABSTRACT

A list of 152 foraminiferal generic and subgeneric names proposed since the Loeblich and Tappan (1987) compilation along with pertinent bibliographic information is presented. In addition, 18 generic names not included in the above compilation are listed.

INTRODUCTION

The rate at which foraminiferal genera are proposed has been well documented by Loeblich and Tappan (1964, 1987). For example, these workers (Treatise on Invertebrate Paleontology, Part C, Protista 2, 1964), presented information on over 2,400 proposed genera and later (Foraminiferal Genera and their Classification, 1987) documented 3,620 genera. This rate has continued unabated since the Loeblich and Tappan (1987) compilation. The purpose of this article is to provide information on the known foraminiferal genera and subgenera proposed since 1987; make objective observations on the validity of these taxa; and where pertinent, elaborate upon information included in the Loeblich and Tappan (1987) volumes. In addition, erroneous citations of previously established taxa are included, as are omissions from, or corrections to, the Loeblich and Tappan (1987) compilation.

The generic and subgeneric names included herein represent those that have come to hand, and no claim is made as to this list being exhaustive. For example, I am personally aware of a further thirteen proposed new genera, either in manuscript or galley format. These genera will be published by Loeblich and Tappan, Revets, Haman *et al.*, and Zhang. It is highly probable that additional new genera are being discovered or described on a daily basis. Thus, it is virtually impossible to keep abreast of the new taxa. However, this listing does present data from multiple sources which may not be readily available to other students of foraminifera, and, may be of assistance in avoiding potential future taxonomic confusion. Each generic entry is followed by the bibliographic citation to facilitate literature usage.

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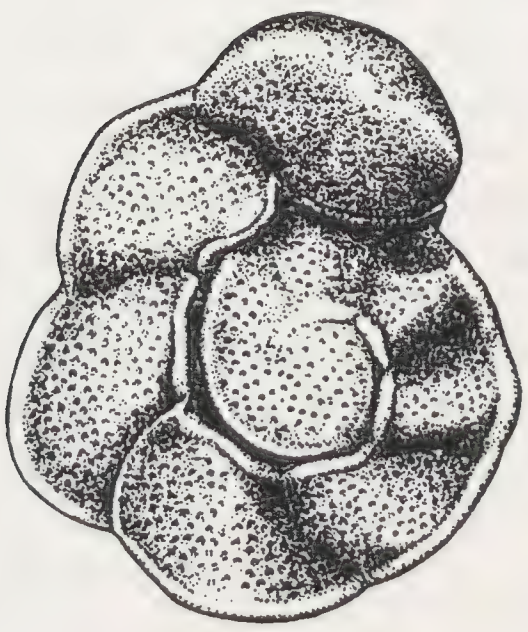

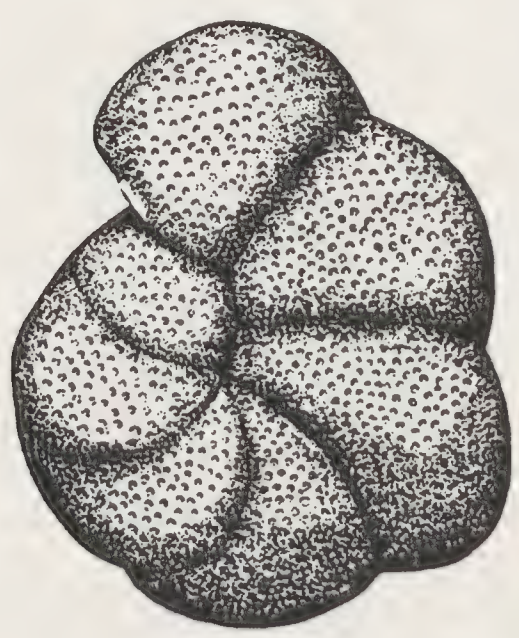

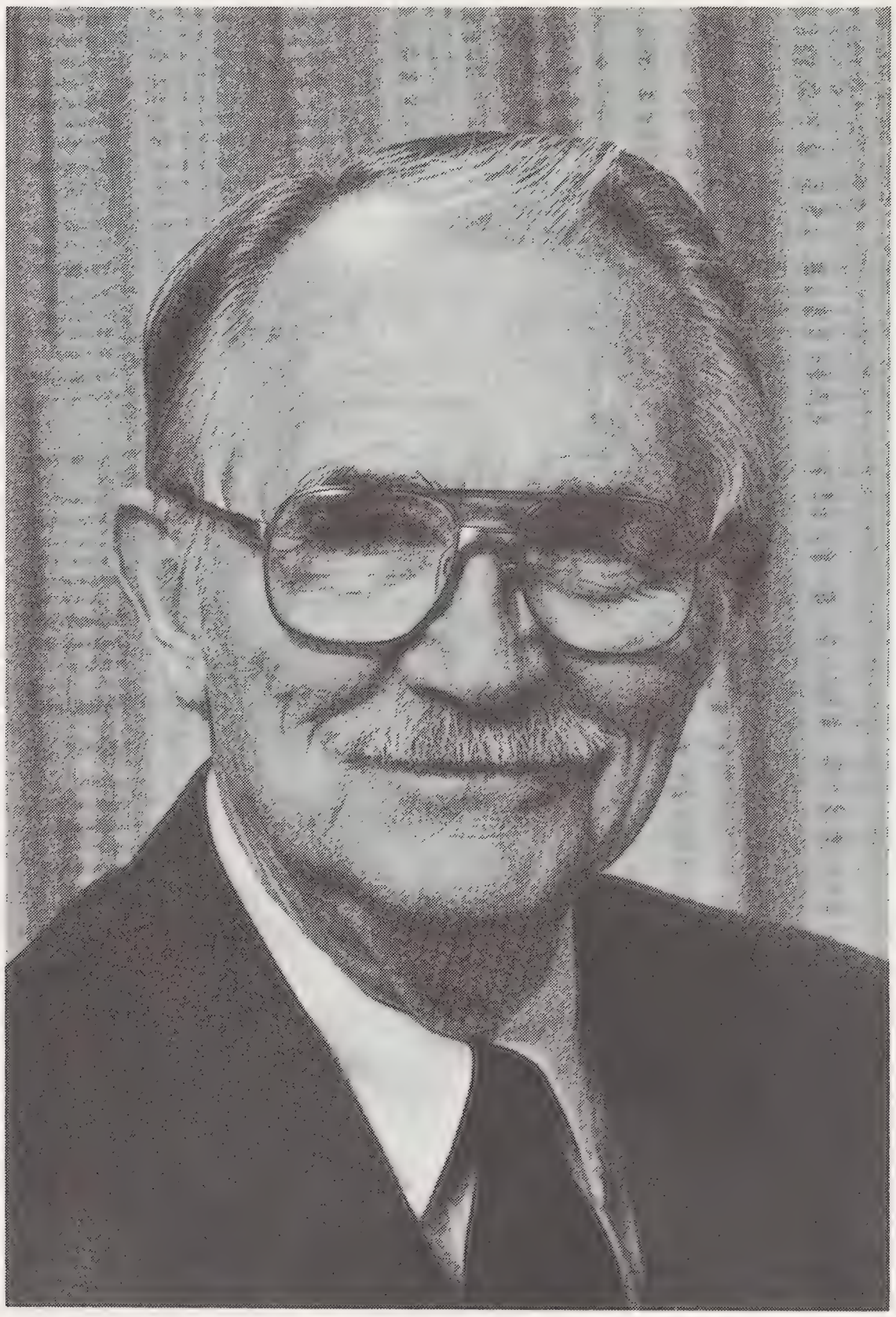

VIGNETTES OF COASTAL PLAIN GEOLOGY

HAROLD VERAL ANDERSEN
(1907-)

Harold V. ("Andy") Andersen's life reads like a Horatio Alger novel. Before he finally completed his Ph.D. degree at Louisiana State University in 1950, he had suffered through the trials of the Great Depression where the need to make a living competed with pursuing an education for his time. He received his B.A. in Geology in 1940 and began Graduate School only to have World War II interrupt his plans. Upon his discharge in 1946 he returned to graduate studies. This time luck smiled upon him and he found himself under the mentorship of Henry V. Howe, completing his dissertation on the foraminiferal fauna of the Mississippi Delta "mudlumps." Dr. Howe recognized his extraordinary abilities as a teacher and insisted that Andy remain at LSU and, with the exception of another brief hiatus with the U.S. Army during the Korean Conflict, there he remained until his retirement in 1977. During his professional career he authored many publications on the Geology and Micropaleontology of Louisiana but his most long lasting contribution without doubt is the extraordinary number of economic micropaleontologists that he trained. Upon the occasion of his retirement, it was decided that a fitting tribute would be the gift of a research microscope with which he could continue his work. Over 150 former students contributed to the gift, as a small token of their appreciation for this beloved teacher. (*From* E.B. Picou, Jr., 1986, Gulf Coast Association of Geological Societies, Transactions, v. 36)

NEOGENE BIVALVE *RANGIA (MIORANGIA) JOHNSONI;* TAXONOMY, DEPOSITIONAL FACIES AND STRATIGRAPHIC RANGE

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I. ABSTRACT

The study of numerous specimens of a fossil bivalve, collected from a Chickasawhay River outcrop in southeastern Mississippi, included statistical tests of valve elongation ratios. Despite their great morphological variety, the molluscan valves were determined to represent only a single species, *Rangia johnsoni*. Valve shape variability appears related to ontogenic development from the young juvenile to adult stages. Diminutive shells, designated previously as "*R. microjohnsoni*," do not belong to a separate, valid species. The term *Miorangia*, employed by Dall and Gardner, is a valid subgeneric taxon. Further use of the terms *Miorangia microjohnsoni*, *M. johnsoni* and *R. microjohnsoni* is unwarranted. *Rangia johnsoni* inhabited not only reduced salinity, estuarine-lagoonal depositional facies but also extended into inner neritic environments. Although most abundant in the Late Miocene units of the Gulf Coastal Plain, its age range includes the upper Middle Miocene and perhaps even the earliest Pliocene.

II. INTRODUCTION

Just over a century ago (1888-1891), Lawrence C. Johnson of the U.S. Geological Survey first observed Miocene shell concentrates composed of a newly discovered bivalve fossil in southeast Mississippi streambanks and in a Mobile, Alabama water well (Fig. 1). The shell beds occur in a clayey-sandy sequence that Johnson (1892) referred to as "Pascagoula clay" or "Pascagoula Formation." Dall (1892-1894) described the new bivalve species as *Gnathodon johnsoni*, assigning it to a *Miorangia* taxonomic "Section" within the genus *Gnathodon*. Later, the generic name *Rangia* was adopted in the literature. Dall (1894) provided an early taxonomic history of the genus.

On the basis of reversed cardinal teeth in *R. johnsoni*, which correspond to Dall's "Section *Miorangia*" (see Appendix), Gardner (1940) recognized the subgenus *Miorangia*, based, in addition, on the obliquely produced submytiloid outline, with a correspondingly asymmetric hinge (see Appendix). In a number of papers *Miorangia* was substituted incorrectly for the established generic name *Rangia* (e.g., "*Miorangia johnsoni*").

Gardner (1940) described a new *Rangia* species, different from *R. johnsoni* "apparently only in the much smaller size." She named it *Rangia (Miorangia) microjohnsoni*, maintaining that the diminutive valves (maximum 5 mm length) were not juvenile forms of *R. johnsoni* but instead represent mature life stages of a separate species. The two *Rangia* forms subsequently have been referred to in the literature by a confusing array of designations: *Miorangia microjohnsoni* and *Rangia johnsoni* (Puri, 1953; Murray, 1961); *Rangia (Miorangia) microjohnsoni* and *Rangia microjohnsoni* (Marsh, 1966; Skinner, 1972; Raymond, 1985). Puri (1953, p. 57) regarded "*Miorangia microjohnsoni*" to be the subsurface equivalent of *Rangia johnsoni*. He defined the stratigraphic range of "*Rangia johnsoni-Miorangia microjohnsoni*" as a faunizone (of the Choctawhatchee Stage), fully correlative with

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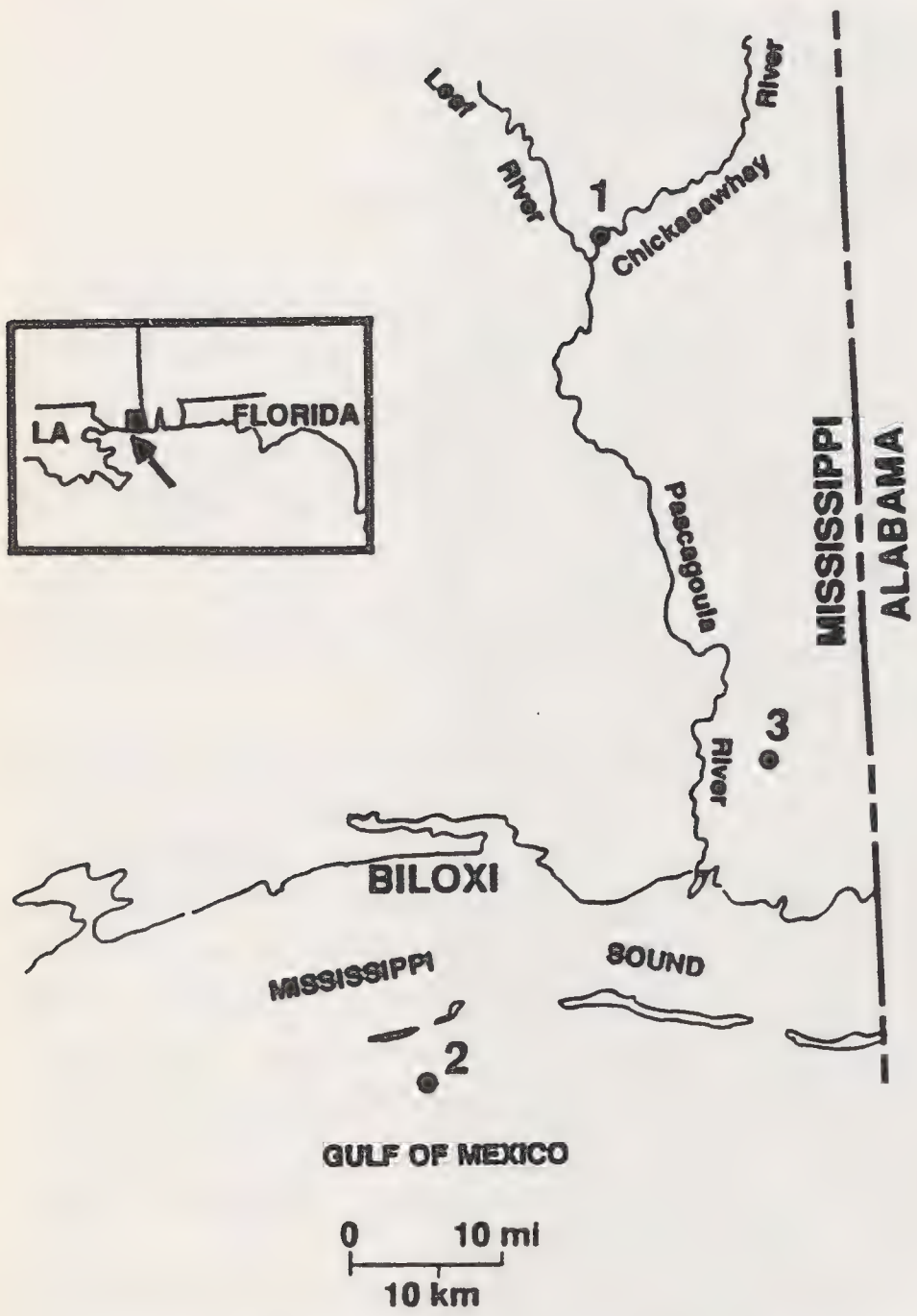

Figure 1. Drillhole and outcrop locations, south Mississippi. Key: 1-Miller Bridge Bluff; 2-Sapphire well; 3-Morton-Thiokol well.

the Pascagoula Formation. Since Gardner's paper, the occurrence of "*M. microjohnsoni*" specimens has been cited in various publications and reports more frequently than *R. johnsoni* has.

A few years ago Jules R. DuBar and David T. Dockery tentatively identified taxa in our southern Mississippi collections as "*Rangia johnsoni/ microjohnsoni.*" DuBar (written comm.) pointed out that although Dall's "ovate" and "triangular" valve shapes, as well as oval-elongate and trigonal-elongate types (Figs. 2, 3) commonly coexist in the drill- and outcrop samples, all appear to represent a single species. DuBar suggested further studies to deal with this question.

III. THE *JOHNSONI* VS. *MICROJOHNSONI* QUESTION

Sampled outcrop.

The taxonomic validity of the *Rangia* species was tested using a large sample, collected from the richest, 40-cm interval in a Chickasawhay River bluff (Figs. 4a,b). This outcrop, referred to here as Miller Bridge Bluff (Fig. 1, Location 1), occurs in Greene County, southeastern Mississippi (center of south section line, sec. 29, T1N, R7W; Leakesville SW USGS Quadrangle). First described by Mincher (1941, p.340), it is at the foot of the right river bank, 1 km downstream from the Highway 98 (Miller) bridge. In 1989 it exposed the sequence given in Table 1.

Mincher (1941) also identified estuarine ostracode and foraminifer species from several nearby "Pascagoula Clay" outcrops along the river. Although he described a new bivalve species, *Ostrea westi* only from another location, we did collect this oyster from Unit (b) of the described outcrop.

Valve morphology variations. A total of 303 well-preserved *Rangia* valves collected from Unit (b) were grouped into four size-categories, according to valve length, in order to test the assumption that increasing size is related to morphological differences. Valve length is measured parallel to hinge line and is the distance between anterior and posterior margins at the farthest points. Height is measured normal to length. Ratios of valve length and height, measured at the University of South Carolina by optical microscope with the accuracy of one micron, have been computed for each individual (Tables 2 and 3).

A detailed visual analysis by Campbell of all valves in the four size-groups of valve lengths ‹3.0 mm, 3.1-6.0, 6.1-12.0 and ›12.1 mm indicated that shape differences in *Rangia (Miorangia) johnsoni* were related to allometric growth stages. Valves of Group One (138 specimens) were generally thin-shelled, with high, sharply pointed subterminal beaks, delicate hinges with small teeth. The generally narrow valves (mean length/height ratio: 1.43) often correspond to Dall's "triangular" shapes, although elongated shapes are not rare either. A broad overlap exists between Groups One and Two in terms of valve shape and elongation ratio. The predominance of triangular, "squat" valves in the smallest size-class as well as the abundance of forms, transitional between triangular and ovate, is clearly pointed out by contrasting elongation ratio curves (Fig. 5). Morphological variety and overlap between size categories is also indicated by

other valves, sampled from drillholes and not included in the present study (Figs. 2, 3).

Group Two (102 specimens) was represented mostly by thicker, more elongate shells. The mean shape ratio (1.62) reached a maximum value in this group. Beaks were terminal, hinges massive, and were equipped with thicker teeth. Many specimens were virtually identical to Gardner's *"Rangia (M.) microjohnsoni"* illustration (1940, Fig. 1).

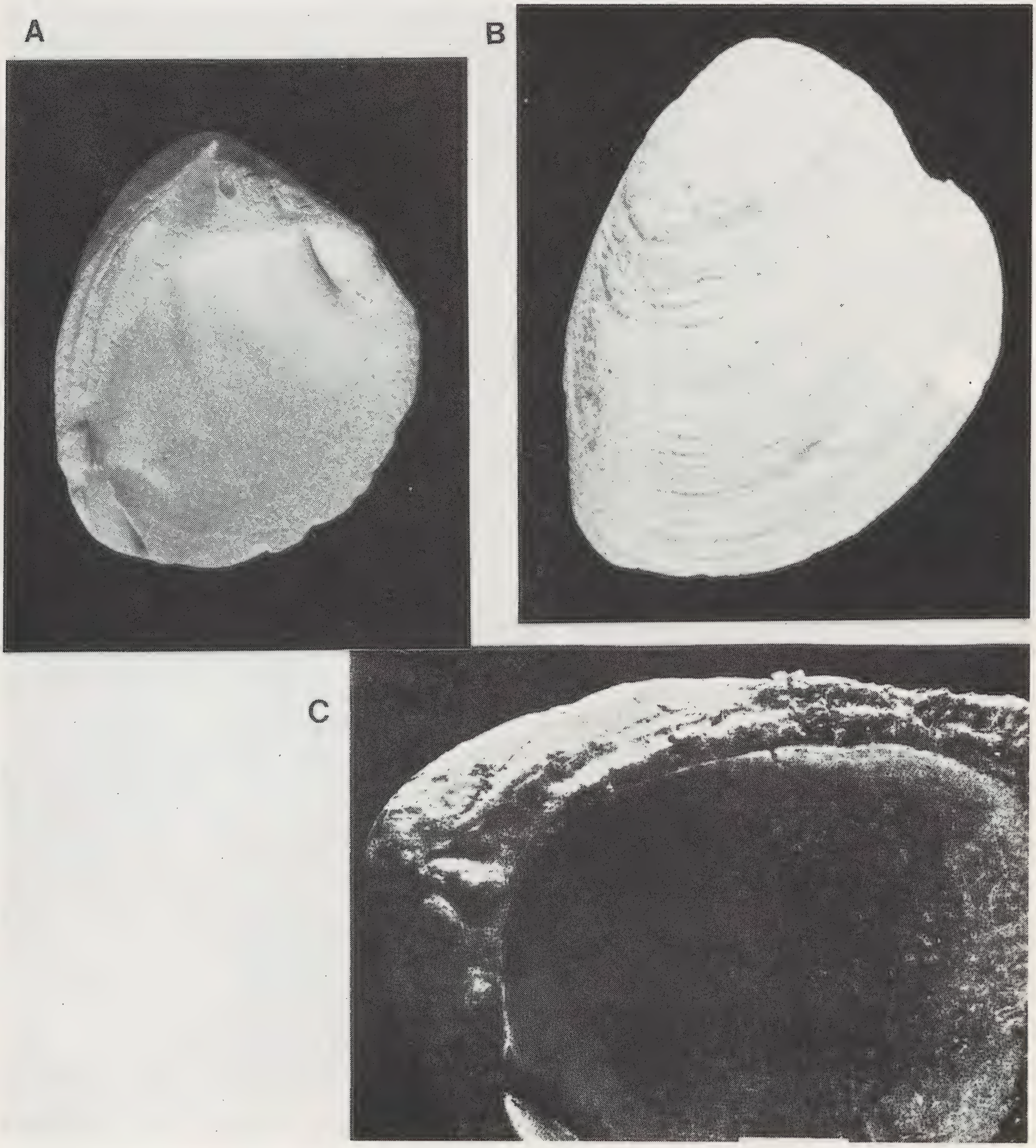

Figure 2. *Rangia johnsoni* trigonal forms from Sapphire Petroleum Co. drillhole (Location 2 on Fig. 1): Binocular microscope photos: (a) left valve interior, length: 16.5 mm, height: 14.3 mm (2730-2760 ft; 832-841 m)); (b) right valve exterior, length: 13.6 mm; height: 12.5 mm (2580-2610 ft; 787-796 m); Morton-Thiokol (Location 3 on Fig. 1) Drillhole: 1929-1960 ft (588-642 m). Length: 3.6 mm, height: 3.5 mm; beak area. SEM image, scale bar: 0.5 mm.

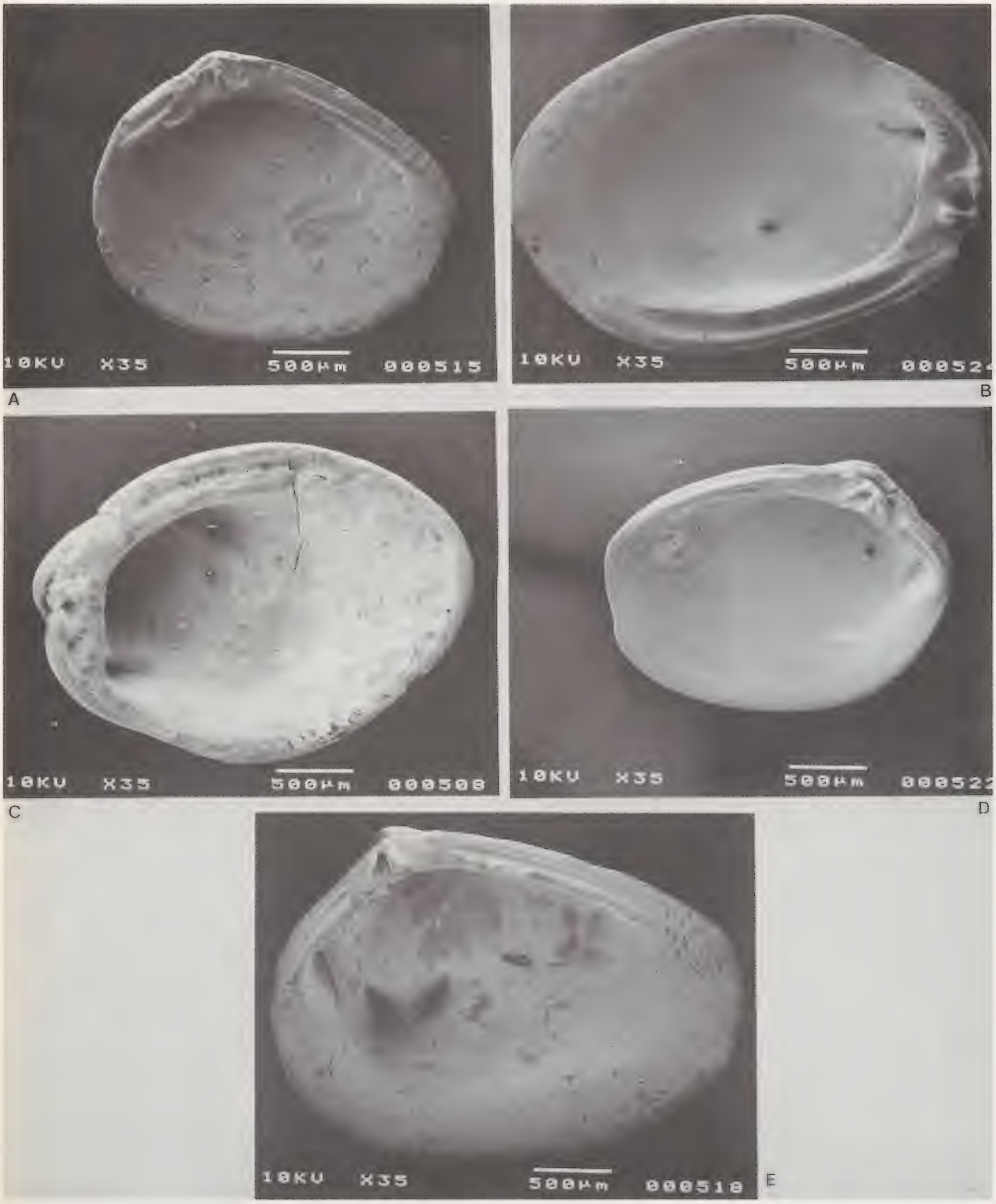

Figure 3. *Rangia johnsoni* oval and oval-elongate forms from Sapphire Petroleum Co. drillhole. (SEM images; scale bar: 0.5 mm.) (a) 3390-3420 ft (1033-1121 m), right valve interior; length: 2.2 mm; height: 1.9 mm (b) 1942-1972 ft (592-601 m) right valve interior, length: 3.3 mm, height: 2.2 mm; (c) 3390-3420 ft (1033-1121 m), right valve interior length: 3.2 mm, height: 1.6 mm; (d) Sapphire 2670-2700 ft (814-823 m), left valve interior, length: 2.4 mm, height: 1.2 mm; (e) Morton-Thiokol, right valve interior 1929-1960 ft (588-642 m); length: 3.1 mm, height: 2.3 mm.

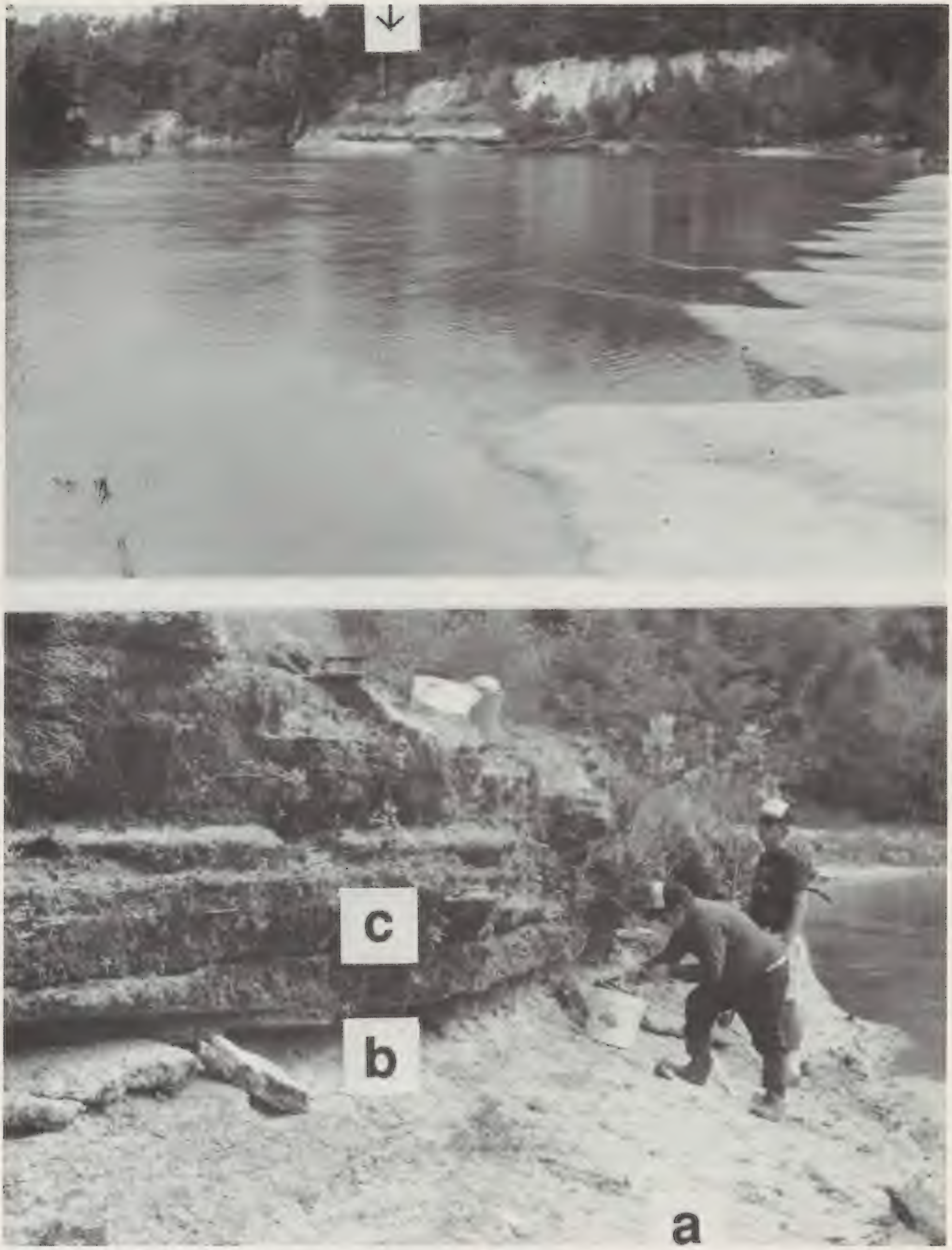

Figure 4. Miller Bridge Bluff; low water stage. (TOP) General downstream view. Outcrop at foot of river bank (arrow). (BOTTOM) Closeup: unconsolidated, thin sampled unit *b;* between units *c* (limestone ledges), and *a* (slope, Messrs. Newby and Howat for scale).

In Group Three (52 specimens) shell walls were thicker but narrower, with massive hinges and low beaks. The mean ratio (1.58) declined slightly from that of Group Two.

Group Four (11 specimens), represented by the largest valves (12-21 mm), had thinner shells. Beaks were relatively higher than in Group Three and terminal. Hinges were less massive and teeth more elongated. The narrow, triangular-shaped valves resembled those that dominated Group One (mean ratio: 1.46).

Species identities: One-way analysis of variance of length/height ratio vs. valve groups.

One-way analysis of variance showed significant differences (alpha <.05) in mean length/height ratios among the four groups. Duncan's Multiple Range Test (Steel and Torrie, 1960, p. 107-114) indicated two distinct subsets, Groups One and Two, significantly different from Groups Three and Two (Table 2).

In contrast, the Scheffe's Procedure (Table 3), which requires larger observed differences for significance (Hicks, 1982, p. 52-53), revealed two overlapping subsets. These subsets, Groups One, Four and Three are not significantly different from each other. There is an overlap between Groups Three and Two. Significant differences exist only between Groups One and Two and Two and Four.

Thus, while both tests showed significant differences within Gardner's *"microjohnsoni"* size-class (combination of Groups One and Two; the dominantly triangular and the dominantly oval-elongate groups, respectively), neither test indicated significant difference between Group Two, those shells were morphologically similar or identical to Gardner's *Rangia microjohnsoni,* and Group Three, those shells that Gardner would have assigned to *Rangia johnsoni.*

Should specimens of two *Rangia* species occur together in the two smaller size-groups, each species would contribute its distinctive values to both groups. Ratio distribution, displayed by a "combined" curve, would then be bimodal, with each species being characterized by a separate ratio frequency curve. But this was not the case. Group One displayed an almost perfect unimodal distribution, with a slight shoulder at ratio 1.1, and the Group Two curve was perfectly unimodal, with a peak value 0.2 greater than in Group One (Fig. 5). In other words, *Rangia johnsoni* juveniles did not coexist with hypothetical *"Rangia microjohnsoni"* adults.

Our analyses, thus, provide no support for the existence of two separate *Rangia* species in the examined material. Instead, morphological differences are attributed to allometric changes. Individual development starts in Group One (young-juvenile ontogenic stage) and continues through Groups Two (older juveniles) and Three (subadults). It culminates in Group Four (fully adult stage). Walls became thicker, progressing from the first to the second group. Typically, this is the sign of maturity among many marine bivalves. However, among species that also inhabit nearshore and inshore environments, this may be an adaptative characteristic to offset corrosive effects of lower salinity waters and organic-rich, slightly acidic substrates.

Table 1. Geologic section, Miller Bridge Outcrop (Location: see Fig. 1).

Pliocene	Citronelle Formation. Yellowish-brown to orange-red, locally cross-stratified alluvial silty sand that forms distinctive high bluff . . . . . 5 m
U.Miocene	Undifferentiated Neogene paralic-alluvial sequence (earlier: "Pascagoula Formation"):
	(f) Grayish-green mud, with silty clay, fossil-free (approximate high-water stage, c. 15 m above sea level) . . . . . 11 cm
	(e) Ironstone ledge, dark grayish-brown to purple-brown, dense, with vertical, limonitized root casts . . . . . 15-25 cm
	(d) Unconsolidated yellowish-brown sand, abundant shell fragments, dominantly *Rangia* shells and shell fragments . . . . . 37-65 cm
	(c) Medium light gray-to-bright white, mostly well consolidated, hard coquina-limestone ledges, composed of *Rangia* shells . . . . . 120 cm
	(b) Moderate greenish-gray clay with *Rangia*-concentrate lenses, shell hash content increases downward (*sampled interval;* Fig. 5) . . . . . 40 cm
	(a) Sandy-clayey shell hash, gray-to-white, with abundant *Rangia* shells . 95 cms
	Extreme low river level

Table 2. Duncan's Multiple Range Test for *Rangia* valve data in the four size categories (groups).

category	1	4	3	2
size range	‹3 mm	›12 mm	6.001-12 mm	3.001-6 mm
mean ratio	1.4394	1.4604	1.5801	1.6271

Table 3. Scheffe's Test for *Rangia* valve data in the four size categories (groups).

category	1	4	3	2
size range	‹3 mm	›12 mm	6.001-12 mm	3.001-6 mm
mean ratio	1.4394	1.4604	1.5801	1.6271

IV. STRATIGRAPHIC POSITION OF *RANGIA JOHNSONI*- BEARING INTERVALS

Data from south Louisiana and Alabama.

The *Rangia* species has been recognized by Johnson, Dall and several other workers as a key fossil in a number of Miocene Gulf coastal stratigraphic units. These included the Fleming Group, Pascagoula Formation, Miocene coarse clastics, Pensacola Clay (Fig. 6) in a wide belt that extends from southern Texas to northwest Florida. In southern Louisiana, the *"Rangia microjohnsoni"* zone is widely regarded as the "updip" correlative of the Late Miocene neritic facies, similar to the relationship that exists between the nearshore *Potamides matsoni* micromolluscan faunizone and the *Globorotalia fohsi fohsi* planktonic zone in the Middle Miocene (E. B. Picou, Jr., written comm.). Ellisor (1940), as well as Akers and Drooger (1957) considered the *"Rangia johnsoni/microjohnsoni"* biozone of uppermost Late Miocene age.

Raymond (1985) quoted other workers in stating that the two *Rangia* species in Louisiana appeared as early as *Globorotalia fohsi peripheroacuta* (Blow Zone N.10; mid-Middle Miocene). This level corresponds to the *Bigenerina humblei* benthic foram zone. E. B. Picou, Jr. (written comm., 1987), expressed reservations about the Middle Miocene age in view of potential contamination of drill samples in drillholes from higher horizons. Raymond (1985, p. 27) also reported *Rangia johnsoni* from the upper part of the Middle Miocene marine Amos Member (Zones N.9-12) in the Alabama "Pensacola Clay" sequence (Raymond, 1985, p. 27). In southern Alabama, *R. johnsoni* apparently occurs at stratigraphically lower levels than does *Globigerina praebulloides* (range from Middle Miocene through lower Late Miocene Zone N.17) in nearshore drillhole, Exxon/Mobile Bay Block 115 (Otvos, 1988).

Gardner (1940) also noted that, although the bivalve is among the youngest Miocene index fossils, the species extends down the section to the Middle Miocene *Potamides matsoni* and *Uvigerina lirettensis* assemblage zones. In the updip area of southwestern Louisiana, Brunhild (1984) placed the species in the lowermost part of the Late Miocene. Tentative evidence is presented here that *R. johnsoni* first appeared in the Middle Miocene, also in coastal Mississippi. The presence of *Globigerina riveroae* of a dominantly Pliocene range (Blow Zones N.18-19) in a marine sediment lense (Otvos, 1988), in offshore drillhole "Mobile Bay Block 1006" between 373-464 ft (113-141 m), tentatively suggests that the youngest *Rangia johnsoni*- fossils may have been of Pliocene age in Mississippi and Alabama. The lower and upper boundaries of the Pascagoula Formation toward the Hattiesburg and the Graham Ferry "Formations," respectively, had been placed on the appearance/disappearance levels of this *Rangia* species. Because of the regressive character of the overwhelmingly alluvial-paralic Late Miocene-Pliocene sequence and the sporadic, isolated occurrence of *Rangia* valves in the lenticular estuarine lithosomes, the appearance and extinction levels of the faunizone can not be accurately demarcated in the sedimentary sequence. Regionally correlatable lithologic horizons that would mark formation boundaries are absent also.

Mississippi drillhole evidence: age and salinity of depositional facies.

Large numbers of *Rangia* valves were collected from cuttings of two deep drillholes (Fig. 1). Depositional environments and ages of the units that contained the fos-

sils were determined by associated foraminifer assemblages.

(1) *Sapphire Petroleum/ Mississippi Sound Block 90.*

J. DuBar (written comm.) identified 839 *"R. johnsoni/ microjohnsoni"* valves and valve fragments in the 1282-3670 ft (391-1119 m), Late Miocene - Early Pliocene(?) interval. Triangular, oval, oval-elongate, and oval-triangular valves occurred together. Reduced salinity conditions that prevailed from the top of the Neogene section down to 2640 ft (805 m) depth, were reflected by benthic foraminifer species *Ammonia beccarii, Elphidium galvestonense, E. latispatium pontium,* and a few *Nonion depressulum matagordanum.* This interval contained 38.6% of the 839 Rangia valves.

Salinity apparently increased in the 2640-3210 ft (805-979 m) interval that contained 39.9% of *Rangia* valves. The possibly Pliocene age of the higher interval is indicated by two planktonic *Globigerina riveroae* specimens (Blow Zones N.18-19), between 2640-2670 ft (805-814 m). Late Miocene microfossils (*Globorotalia pseudomiocenica, Globigerina praebulloides, Brizalina marginata multicostata,* etc.) occurred between 2670-3900 ft (814-119 m). Nearshore-to-neritic conditions prevailed between 3210-3670 ft (979-1112 m), a core interval that contained 21.4% of the *Rangia* individuals. *Buliminella elegantissima* dominated, along with a variety of other species (*Epistominella pontoni, E. vitrea, Brizalina marginata multicostata, Buliminella* sp. cf. *B. bassendorfensis, Hanzawaia strattoni,* and others.). The abundance of *"Rangia johnsoni/ microjohnsoni"* valves throughout both the lower and the higher salinity intervals, strongly suggests the salinity tolerance of the species and downplays the importance of fall-ins from the higher, brackish horizons.

(2) *Morton-Thikokol, Jackson County, drillhole.*

Rangia johnsoni specimens were abundant in the middle and upper portions of the 904-2493 ft (275-760 m) Late Miocene-

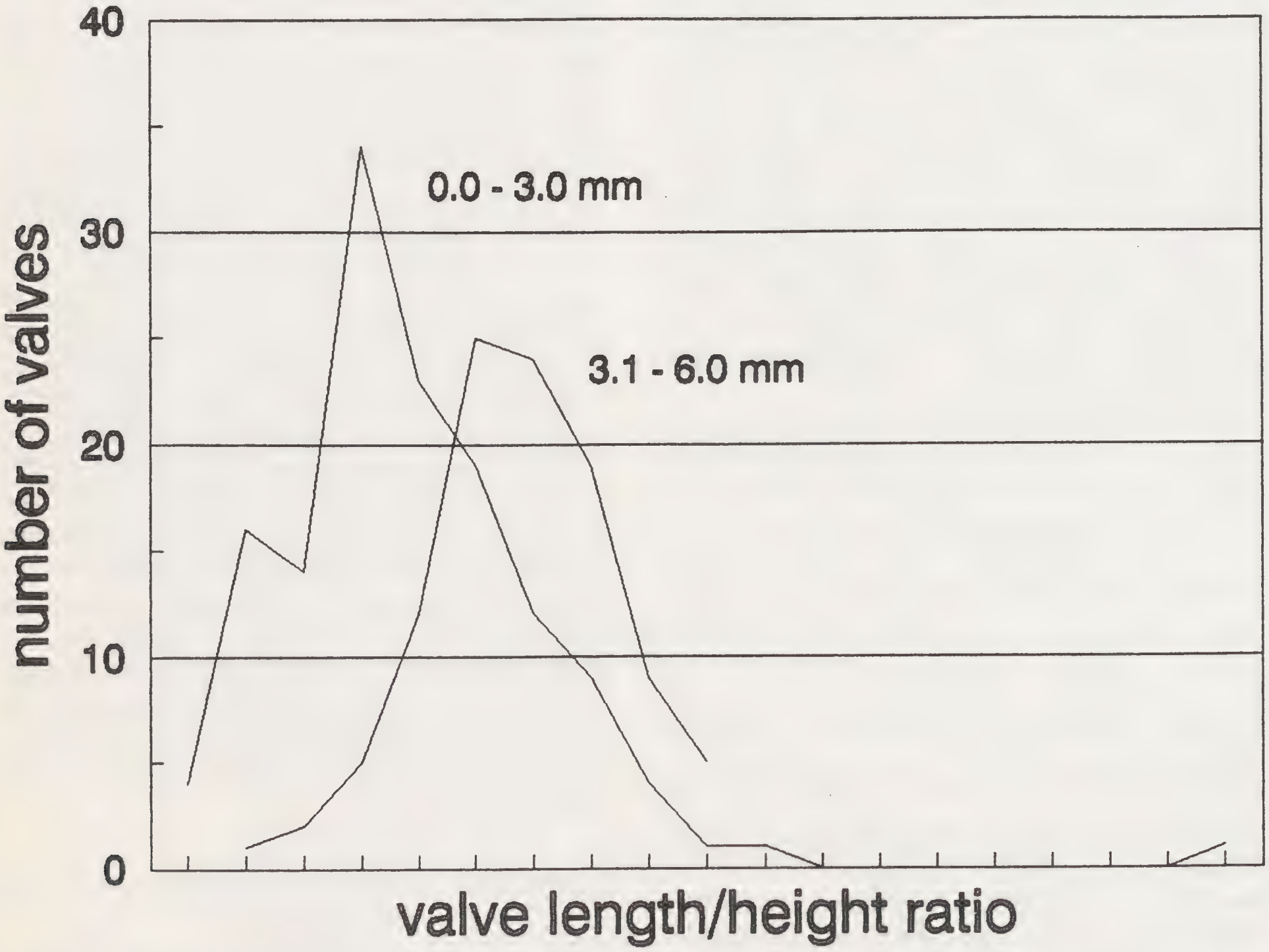

Figure 5. Separation of modes and overlap between *Rangia johnsoni* Group One (0-3.0 mm; dominantly squat, triangular valves) and Group Two (3.1-6.0 mm; dominantly oval-elongate valves).

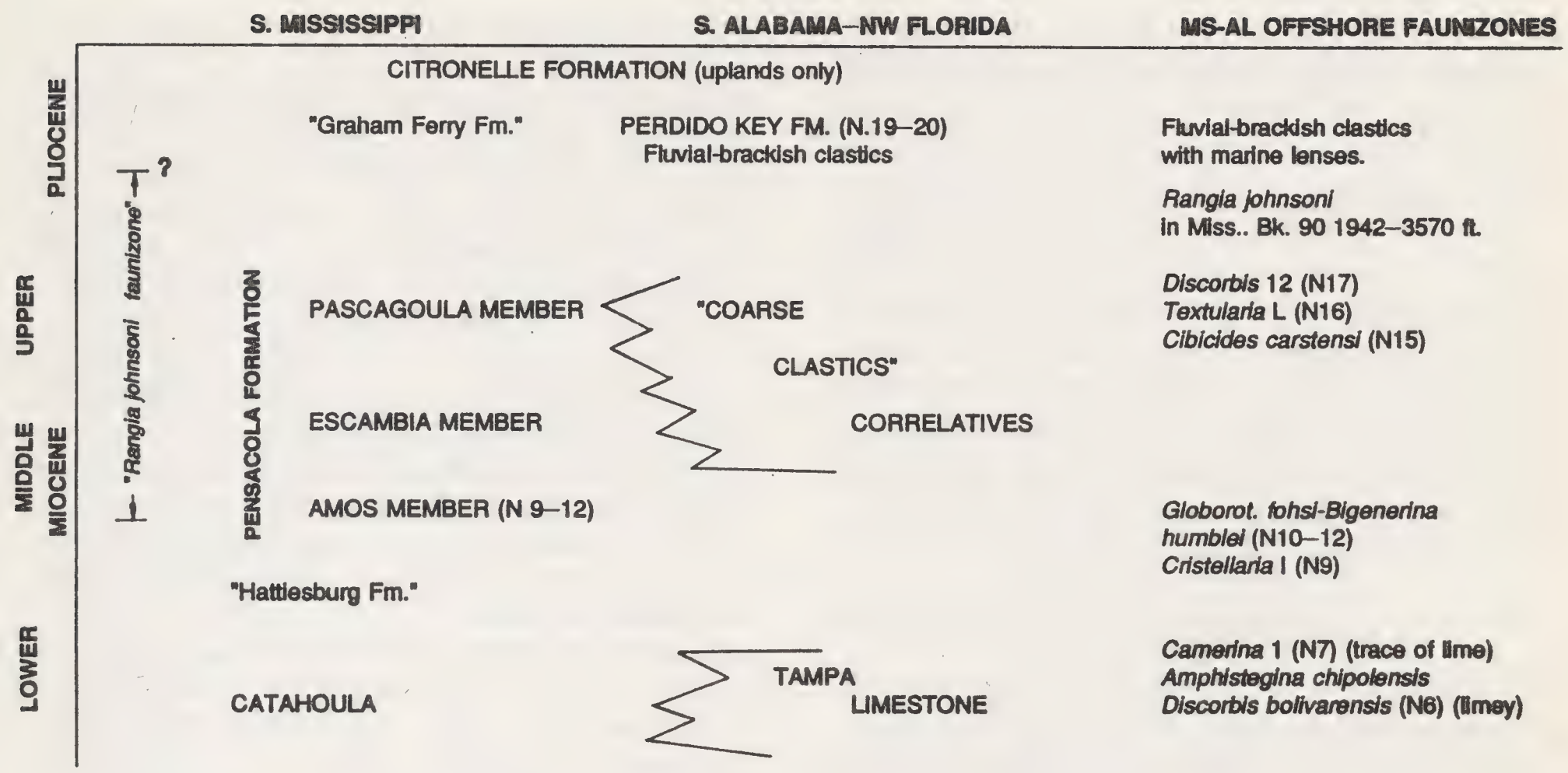

Figure 6. *Rangia johnsoni* faunizone range in updated north-central Gulf coastal plain Neogene stratigraphic sequence (Otvos, 1988 and 1991).

Pliocene? interval. DuBar (written comm.) described the same morphological diversity here as in the other investigated sequences. Low salinity depositional conditions existed between 904-2212 ft (275-674 m), characterized by the dominance of *Ammonia beccarii* and *Elphidium* species, as well as the absence of age-diagnostic planktonic species. Only five specimens of *Rangia johnsoni* occurred below 2243 ft (684 m), in a Middle Miocene (Zone N.9) outer shelf interval with *Globorotalia peripheroronda* (N.4-10), *G. peripheroacuta* (N.9-10), *G. mayeri* (N.9-13), *Globoquadrina dehiscens*, and other planktic taxa. These *Rangia* valves may well have been fall-ins.

V. CONCLUSIONS

Rangia valves from one coastal Mississippi outcrop and two drillholes belong only to one species, *R. (Miorangia) johnsoni*. Differences in the appearance of the valves, expressed in the great variability of length/height ratios, beak position, hinge and teeth structure and shell thickness, appear to be related to ontogenic stages in the development of the individual bivalves. The material at hand provides no evidence to warrant continued use of the terms *Rangia (Miorangia) microjohnsoni*, *Rangia microjohnsoni* or *Miorangia johnsoni*.

Available evidence, still to be supplemented by additional collections from other intervals, suggests a longer stratigraphic range for the species than the commonly accepted Late Miocene interval (Fig. 6). The faunizone ranged from the late Middle Miocene to conceivably into the earliest Pliocene. Due to the lack of precisely datable marine Pliocene lenses, to correlate with adjacent *Rangia*-bearing interval in the alluvial-paralic Neogene sequence, the upper limit of the bivalve's age range can not be firmly established. The absence of regionally correlatable and firmly datable lithologic units that would mark formation boundaries and the spotty appearance of *R. johnsoni*-bearing lenses in the Neogene clayey-sandy sequences are, in addition, among the reasons why Johnson's (1892) "Hattiesburg" and "Pascagoula" – although widely used in the literature – are unacceptable as valid formation designations (Otvos, 1985 and 1991). This is also why horizontal time-lines (e.g., between the Lower and Middle Miocene) would be inappropriate in a stratigraphic table (Fig. 6) to subdivide nondescript alluvial-brackish sequences.

Although its extant "cousin" *Rangia cuneata* (Sowerby, 1832) occupies the very low salinity estuarine niche exclusively (LaSalle and Cruz, 1985), as upper intervals in Mississippi's undifferentiated coast-

al Neogene sequence (Otvos, 1985, p. 5), evidence confirms that during late Middle Miocene and early Late Miocene times *Rangia johnsoni* thrived also in higher salinity nearshore marine waters that were relatively uninfluenced by fresh water runoff. This view is in agreement with Skinner's (1972), according to which in south Louisiana *"Rangia microjohnsoni"* lived in nearshore marine waters, less than 50 feet (15 m) deep. Adaptation to exclusively low-salinity environments may have taken place during Late Miocene-earliest Pliocene(?) regressive stages.

VI. ACKNOWLEDGMENTS

Jules DuBar and David T. Dockery assisted the study in the early stages with fossil identification. DuBar suggested further research directions. Wayne D. Bock identified the Neogene foraminifers. Thanks are due to Walter Brehm, Head of Gulf Coast Research Laboratory's Computer Center, who executed the ANOVA and multiple range tests. He also interpreted and helped to summarize statistical results. Wade E. Howat and Howard Newby of the GCRL Geology Section, assisted with sample collection, well-sitting on the Morton-Thiokol well, and laboratory work. Robin Overstreet and Robert Allen, GCRL, also provided essential help in optical macroscopic and SEM sample preparation, as well as photography.

Miss Katie Harlan measured the valves in preparation for statistical analysis. The editorial work, comments by Dr. Emily H. Vokes, as well those of Drs. David T. Dockery, William Miller and George C. Flowers were sincerely appreciated.

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APPENDIX: SYSTEMATIC PALEONTOLOGY

Family MACTRIDAE
Genus *Rangia* Desmoulins, 1832

Synonyms (from Vaught, 1989, p. 130 and Abbott, 1974, p. 491)

Gnathodon Gray *in* Sowerby, 1832 (*non* Oken, 1816, *non* Goldfuss, 1820).
Clathrodon Conrad, 1833 (error)
Colombia Blainville *in* Rang, 1834, nomen nudum
Perissodon Conrad, 1863
Columbia Dall, 1898 (error)

Type by monotypy: *Rangia cyrenoides* Desmoulins (= *Gnathodon cuneatus* Gray *in* Sowerby, 1832).

The genus *Gnathodon* Gray apparently predates *Rangia* Desmoulins, but the former is twice preoccupied and therefore unavailable.

Subgenus *Miorangia* Dall, 1894

Type by monotypy: *Gnathodon johnsoni* Dall, 1893.

"*Miorangia* differs from *Rangia* sensu stricto in the smaller size, the obliquely produced, submytiloid outline, the correspondingly asymmetric hinge, and in the detail of the cardinal dentition" (Gardner, 1940, p. 477).

In addition to the differences noted by Gardner, the posterior-lateral tooth of the left valve in *Miorangia* is cross-striated on both its dorsal and ventral surfaces. In *Rangia cuneata* these striations are restricted to the dorsal surface of the tooth.

Rangia (Miorangia) johnsoni (Dall, 1893)

Synonymy:

Venus mobiliana JOHNSON, 1892, p. 151, nomen nudum
Gnathodon Johnsoni DALL, 1892, p. 165, nomen nudum
Gnathodon johnsoni DALL, 1893, p. 337, Pl. 22, fig. 18.
Gnathodon (Section *Miorangia) johnsoni* Dall. DALL, 1894, p. 100, Pl. 7, fig. 7
Rangia (Miorangia) johnsoni (Dall). GARDNER, 1940, p. 477
Rangia (Miorangia) microjohnsoni GARDNER, 1940, p.476-477, Figs.1-2
Rangia johnsoni (Dall). PURI, 1953, p. 57
Miorangia microjohnsoni (Gardner). PURI, 1953, p. 57
Rangia johnsoni (Dall). MURRAY, 1961, pp. 411, 413, 418
Miorangia microjohnsoni (Gardner). MURRAY, 1961, pp. 413, 418

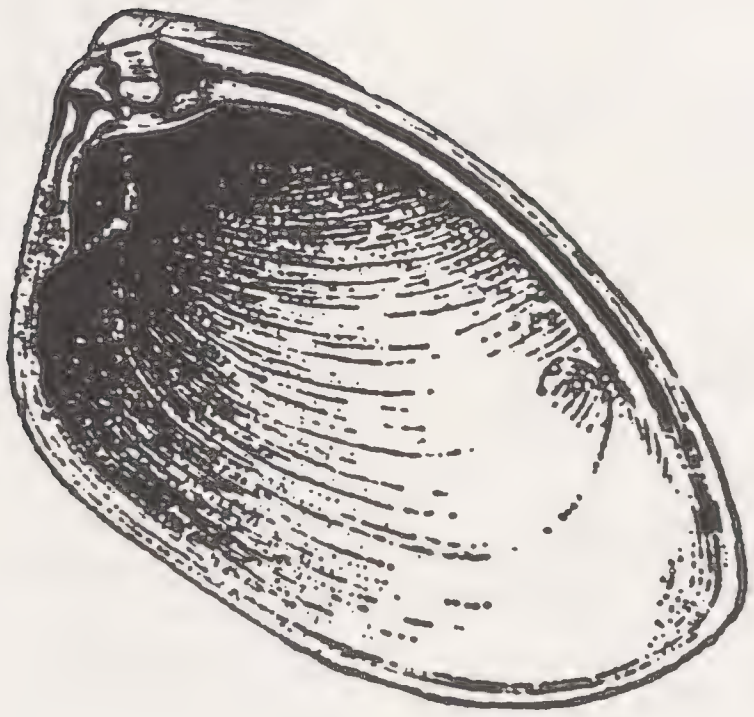
DESCRIPTION (Dall, 1894, pp. 100-101):

"Shell small, rather compressed, ovate-triangular to submytiliform in outline, rather thin for the genus, externally smooth or marked only with lines of growth when perfectly normal, but frequently concentrically fluctuate owing to irregularities of growth; beaks prominent, compressed, anterior, close to the hinge line; margin of the shell entire, with no circumscribed lunule or escutcheon; interior smooth, muscular impressions small, distinct; pallial line with a shallow incurvation behind, hinge very asymmetrical, the anterior lateral tooth in the left valve short, ʌ-shaped, received in the right valve into a corresponding sulcus, below which a triangular pustule represents the anterior lateral of that valve; cardinal teeth of the left valve diverging, lamellar, the anterior lamella situated above the anterior lateral tooth, fitting above a triangular cardinal tooth grooved or partly split at the apex, in the right valve; posterior lateral tooth in the left valve long, arched, finely crenate above, received in the right valve between two slender laminae, of which the lower one is most prominent; pit for the ligament and cartilage narrow, oblique, roofed over by a very thin shelly layer generally worn off in rubbed specimens. Length of shell 17.5; height 1.15; double diameter of valve 10 mm. Fragments indicate that the species reached a length of at least 25 mm."

Note: Dall (1894) and all subsequent authors cite the first valid notation of this species as "Dall, 1892 (December)." Spamer

and Forster (1988) mention that Dall's second 1892 paper (referred to here as Dall, 1893) was actually published in February, 1893. Dall's 1894 description contained a typographic error for the height value. The corrected value is 11.5 mm; the corresponding length/height ratio for his type specimen, 1.52.

December 9, 1992



A NEW SPECIES OF *DICATHAIS* (GASTROPODA:MURICIDAE) FROM THE PLIOCENE TAMIAMI FORMATION OF SOUTHERN FLORIDA

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NEW ORLEANS, LOUISIANA

Dicathais, a thaidine gastropod genus presently restricted to the Recent of Australia, New Zealand, Norfolk, Lord Howe, and Kermadec Islands (Phillips *et al.*, 1973), is herein reported from the Pliocene Tamiami Formation of southern Florida. *Dicathais handgenae,* n. sp., represents the first record of the genus outside Australasia and only the second known fossil occurrence of the genus. Suter (1913) and Beu and Maxwell (1990) have listed *Thais orbita* (Gmelin, 1791), the type species of *Dicathais,* as ranging from early Pliocene to Recent in New Zealand. To date, no other references to fossil *Dicathais* have been found.

Almost seventy specimens of *Dicathais handgenae,* n. sp., are known to exist and the majority are reposited in the Florida Museum of Natural History at the University of Florida (UF). The best preserved specimens were collected between 1987 and 1991 from two UF localities in Charlotte County, CH003 (type locality) and CH026. At UF locality CH003 most specimens were adults and were tan in color, but at UF locality CH026 most specimens were juveniles and were dark brown in color.

Specimens from both localities were collected from a sandy-clay matrix, which was devoid of all aragonitic-shelled mollusks. Only calcitic-shelled invertebrates typically associated with the Tamiami Formation were found. Examples of these include the gastropods *Ecphora quadricostata* (Say, 1824), *Pterorytis fluviana* Dall, 1903, and *Vokesinotus lepidotus* (Dall, 1890), and the echinoids *Encope tamiamiensis* Mansfield, 1932, *Mellita aclinensis* Kier, 1963, and *Rhyncholampas evergladensis* (Mansfield, 1932). The shell of *Dicathais,* like all thaidines, consists of a calcitic outer layer and an aragonitic inner layer (Kool, 1989). All the fossil specimens used in this study have only the calcitic outer layer remaining.

Specimens of *D. handgenae,* n. sp., were recognized from ten additional localities (six in Charlotte County, two in Hendry County, and one each in De Soto and Collier Counties; see text-figure 1) in two collections (the McGinty and Hunter Collections) recently acquired by the University of Florida and from materials donated by Tulane University for this study.

The disjunct distribution of *Dicathais* during the Pliocene probably represents a relict population, which once had a much wider distribution. Thaidines, in general, are rarely preserved in the fossil record because of their preferred habitat of hard substrates in mostly intertidal to subtidal, epifaunal environments (Vokes, 1989, p. 87). This may account for the lack of additional fossil occurrences of *Dicathais.*

ACKNOWLEDGMENTS

The following individuals are thanked for assistance with collecting or donation of specimens of the new species of *Dicathais:* Anna Handgen, Susan and Jim Pendergraft, Kevin Schindler, Lelia and William Brayfield, Muriel Hunter, and Phillip and Debbie Whisler. Lewis Handgen and Jimmy and Pat Philman kindly allowed access to their shell pits, UF localities CH003 and CH026, respectively. Dr. Silvard Kool shared his extensive knowledge of Recent thaidines and provided helpful comments and suggestions during the preparation of the manuscript. Craig Oyen assisted with photography and Wendy Zomlefer prepared the illustration in text-figure 2. We acknowledge the support of National Science Foundation Grant BSR-9002689. This is University of Florida Contribution to Paleontology 392.

SYSTEMATIC PALEONTOLOGY

Class GASTROPODA
Order NEOGASTROPODA
Superfamily MURICACEA

Family MURICIDAE Rafinesque, 1815
Subfamily THAIDINAE Jousseaume, 1888
Genus DICATHAIS Iredale, 1936

Dicathais IREDALE, 1936, Rec. Australian Mus., v. 19, no. 5, p. 325.

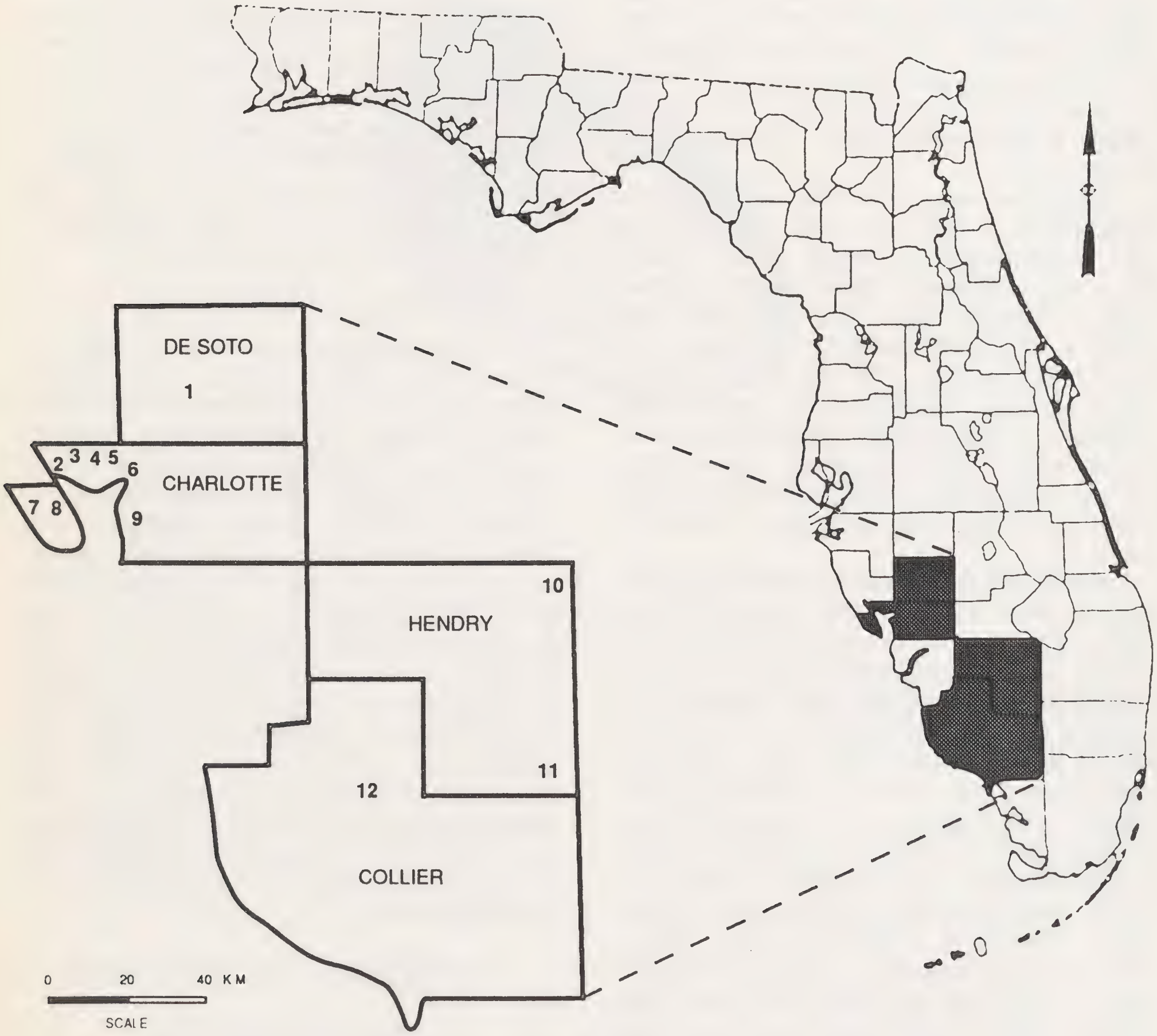
Type species: *Buccinum orbita* Gmelin, 1791, by original designation.

DICATHAIS HANDGENAE
Portell and Vokes, n. sp.
Plate 1, figures 1, 2;
text-figure 2

Description: Shell inflated, reaching a maximum height of about 76 mm and diameter about 54 mm; oval in outline, comprising 4+ whorls (protoconch and early whorls absent or obscured by hardened matrix on most specimens). Shell spire low, body whorl greater than three-fourths of shell height. Teleoconch whorls sculptured with 7 to 9 occasionally nodose, primary spiral ridges; secondary cords of varying strength and fine tertiary cords between each. Area between anterior-most major cord and anal fasciole with only tertiary threads. Suture incised, crossed by axial laminae. Aperture wide, elliptical, outer lip thin, crenulated and lirate within. Siphonal canal short, forming a curved fasciole.

Holotype: UF 21367; height 71.4 mm, diameter 48.3 mm (Plate 1, figs. 1a, 1b).

Type locality: UF locality CH003, Tamiami Formation; shell pit 1.9 kilometers south of Al-



Text-figure 1. Map showing position of all known UF localities for *Dicathais handgenae* n. sp. (1. DE006, 2. CH020, 3. CH030, 4. CH029, 5. CH031, 6. CH032, 7. CH025, 8. CH026, 9. CH003, 10. 3736, 11. 3737, 12. CR001).

ligator Creek along US 41, approximately 1.2 kilometers southeast of Acline, Charlotte County, Florida (SW 1/4, SE 1/4, Sec. 28, T41S, R23E; Punta Gorda Quadrangle, USGS 7.5 minute series).

Paratype A: UF 32295; height 79.0 mm, diameter 48.3 mm; UF locality CH026.

Paratype B: UF 24516; height 63.6 mm, diameter 43.2 mm; UF locality CH003.

Paratype C: UF 29327; height 62.1 mm, diameter 44.1 mm; UF locality CH003.

Paratype D: UF 29330; height 65.7 mm, diameter 46.1 mm; UF locality CH003.

Paratype E: UF 29334; diameter 75.6 mm, width 54.4 mm; UF locality CH003.

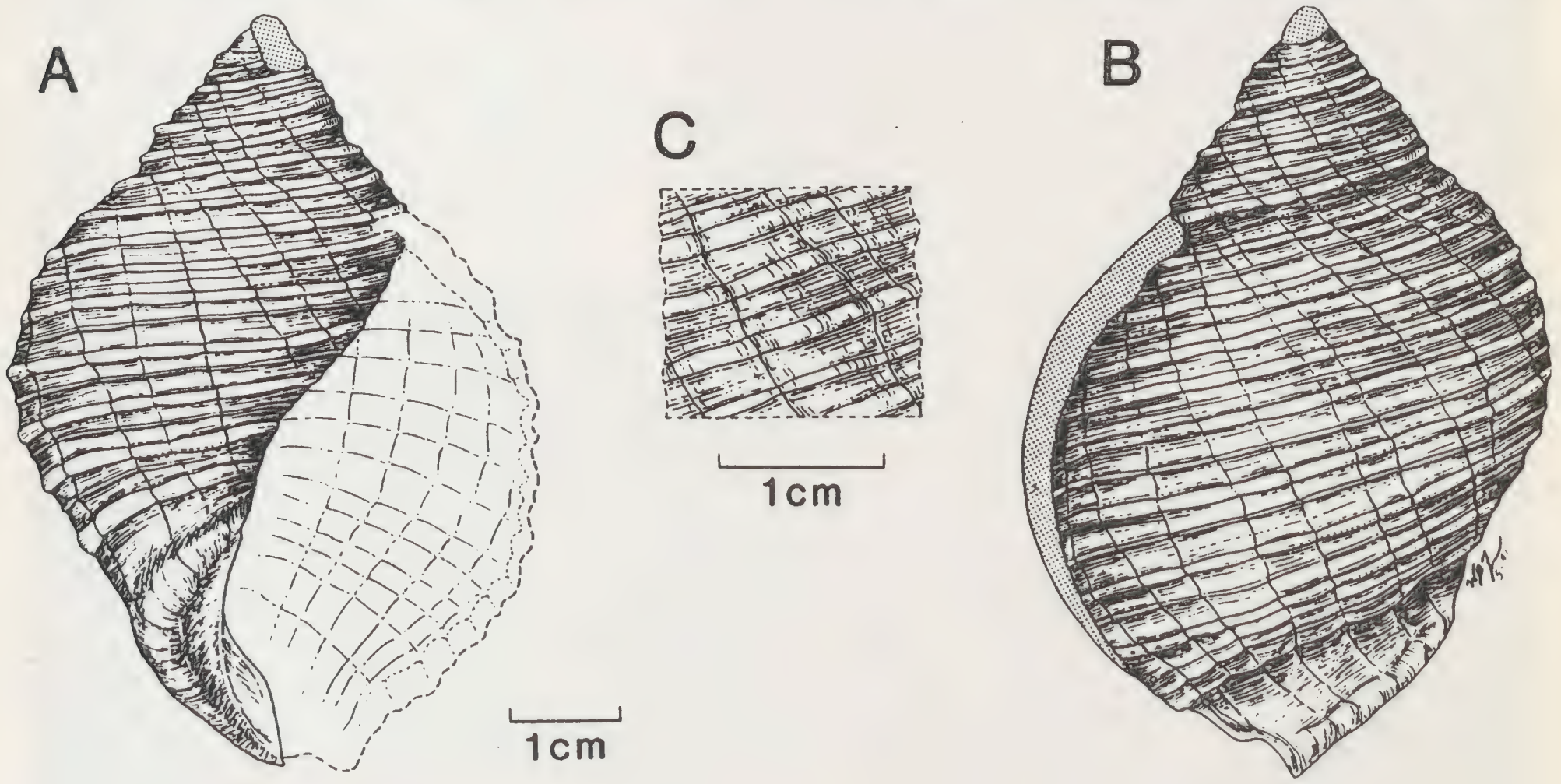
Paratype F: UF 40562; juvenile, height 37.3 mm, diameter 25.6 mm; UF locality 3736 (Plate 1, fig. 2).

Occurrence: Tamiami Formation, southern Florida; Pliocene.

Etymology: Named for Mrs. Anna Handgen of Punta Gorda, Florida, who collected and unselfishly donated most of the best specimens from UF locality CH003.

Discussion: Comparisons of the fossil material made with Recent specimens of *Dicathais* from the collections of Tulane University and the Division of Malacology, Florida Museum of Natural History show that *D. handgenae* closely resembles the Recent Australian species *D. orbita* (Gmelin, 1791) in overall size and shape. The shells of the extant *Dicathais* represent extreme degrees of variability in shell sculpture and most of the described species [i.e., *D. aegrota* (Reeve, 1846), *D. textilosa* (Lamarck, 1816), *D. scalaris* (Menke, 1829)] appear to represent ecologically determined forms of *D. orbita*, a single highly variable species (Phillips *et al.*, 1973). Like the living *D. orbita*, *D. handgenae* also exhibits a high degree of variation. Some examples are noticably nodose, some are much more elongate than the type material. The strength of the spiral cords is also variable with certain of the secondary cords approaching the strength of the major cords.

Given the variability of the living *Dicathais orbita*, it is extremely difficult to arrive at any particular characteristic that separates *D. handgenae*. From the typical "Cart-Rut" form of *D. orbita* there is no problem with differences, *D. handgenae* never (so far as we know!) develops the deeply incised spiral cords. But the less ornamented *D. textilosa*, *D. scalaris* (see pl. 1, fig. 3), and the nodose *D. aegrota* forms are strikingly similar to various examples of *D. handgenae*. The only constant difference is the development in *D. handgenae* of a "blank" area between the anterior-most spiral cord and the anal fasciole. In the Recent species the spiral cords extend all the way to the fasciole, but in *D. handgenae* there is an unornamented band between



Text-figure 2. *Dicathais handgenae* Portell and Vokes, n. sp. Sketch of UF 21367 (holotype): a) ventral view of shell if hardened matrix could be removed from aperture; b) dorsal view; c) details of sculpture on body whorl.

the two (see text-fig. 2B). Unfortunately, there are no specimens with preserved protoconchs yet known of *D. handgenae*. However, the protoconch is probably like that of *D. orbita*, with four large whorls, indicating planktotrophic development, which would be consistent with the disjunct distribution.

Other than the fossil occurrence of *D. orbita* in New Zealand, no other fossil representatives of this genus are known. In Florida the only other Pliocene thaidine is *Thais (Stramonita) haemastoma floridana* (Conrad, 1837), which is easily distinguished by the smoother shell surface, the appressed suture, and the presence of knobs or an angulation at the shoulder.

Dicathais handgenae was also compared to the other living thaidines from the western Atlantic but does not resemble any of those.

LOCALITY DATA

The following are collecting localities of the Invertebrate Paleontology Division, Florida Museum of Natural History, University of Florida (UF). All are in the Tamiami Formation.

CH003 Shell pit 1.9 kilometers south of Alligator Creek along US 41, approximately 1.2 kilometers southeast of Acline, Charlotte County, Florida (SW 1/4, SE 1/4, Sec. 28, T41S, R23E; Punta Gorda Quadrangle, USGS 7.5 minute series).

CH020 Shell pit approximately 0.8 kilometer northwest of El Jobean, Charlotte County, Florida (Sec. 21, T40S, R21E; El Jobean Quadrangle, USGS 7.5 minute series).

CH025 Shell pit approximately 0.8 kilometer east of Grove City, Charlotte County, Florida (NW 1/4, NE 1/4, Sec. 16, T41S, R20E; Englewood Quadrangle, USGS 7.5 minute series).

CH026 Shell pit approximately 1.2 kilometers east of Grove City, Charlotte County, Florida (NE 1/4, NE 1/4, Sec. 16, T41S, R20E; Englewood Quadrangle, USGS 7.5 minute series).

CH029 Banks of Jupiter Waterway north of US 41, approximately 5.3 kilometers west of Murdock, Charlotte County, Florida (NE 1/4, Sec. 3, T40S, R21E; Murdock Quadrangle, USGS 7.5 minute series).

CH030 Banks of Jupiter Waterway south of US 41, approximately 5.3 kilometers west of Murdock, Charlotte County, Florida (S 1/2, Sec. 3, T40S, R21E; Murdock Quadrangle, USGS 7.5 minute series).

CH031 Banks of Pellam Waterway near intersection with US 41, approximately 0.8 kilometer east of Murdock, Charlotte County, Florida (W 1/2, Sec. 8, T40S, R22E; Murdock Quadrangle, USGS 7.5 minute series).

CH032 Exposure near west side of SR 776 bridge over Myakka River, El Jobean, Charlotte County, Florida (Sec. 28, T40S, R21E; El Jobean Quadrangle, USGS 7.5 minute series).

CR001 Quarry on west side of SR 29, Sunniland, Collier County, Florida (W 1/2, Sec. 29, T48S, R30E; Sunniland Quadrangle, USGS 7.5 minute series).

DE006 Shell pit 2.6 kilometers east of junction of US 17 and SR 760, Nocatee, De Soto County, Florida (NE 1/4, SE 1/4, Sec. 24, T38S, R24E; Arcadia Quadrangle, USGS 7.5 minute series).

3736 Near Clewiston, Hendry County, Florida.

3737 Seminole Indian Reservation, just off CR 833, Hendry County, Florida.

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PLATE 1

Figures

1-2. *Dicathais handgenae* Portell and Vokes, n. sp.

1. UF 21367 (holotype); height 71.4 mm, diameter 48.3 mm.
Locality: UF locality CH003.

2. UF 40562 (paratype F); height 37.3 mm, diameter 25.6 mm.
Locality: UF locality 3736.

3. *Dicathais orbita* (Gmelin, 1791)
UF 193522; height 78.7 mm, diameter 50.4 mm.
Locality: Murawai, New Zealand; Recent.

(All specimens X 1)

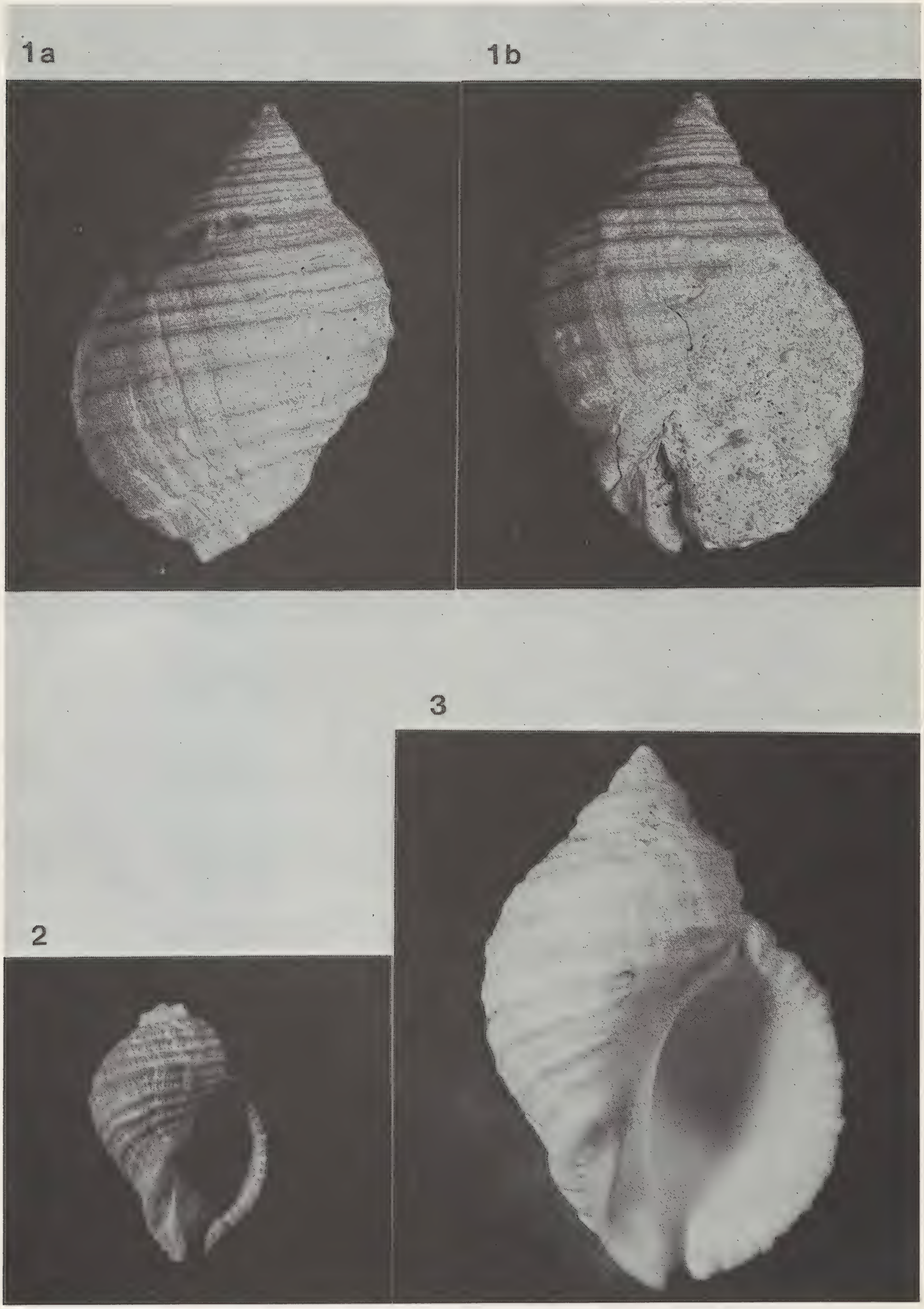

PLATE 1

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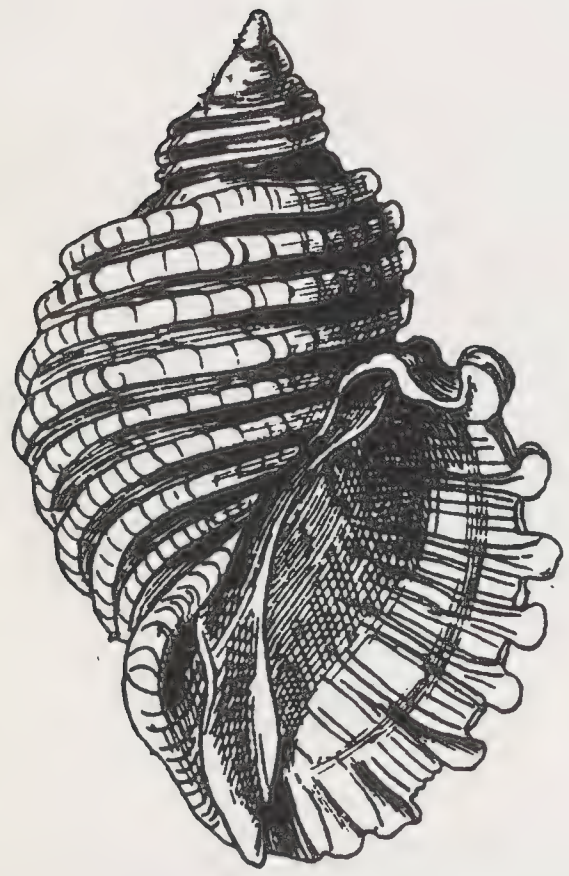
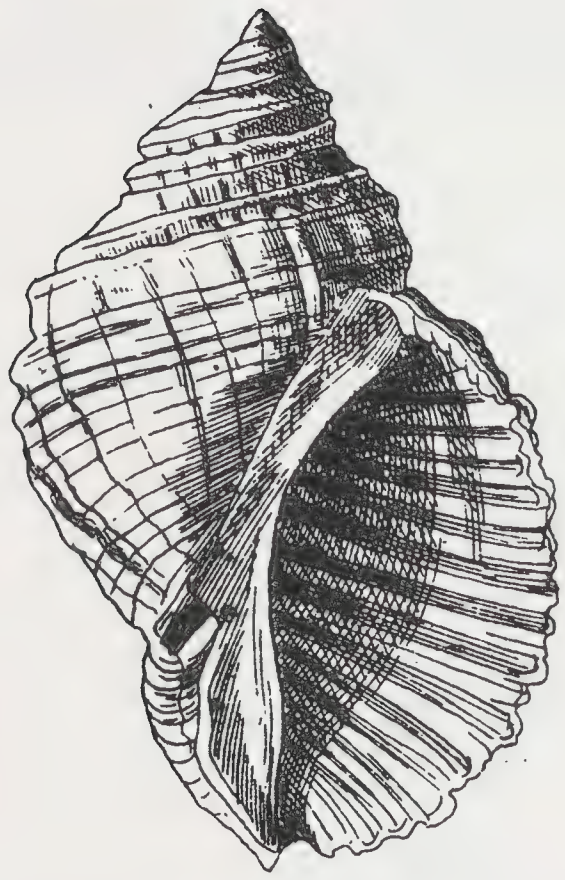
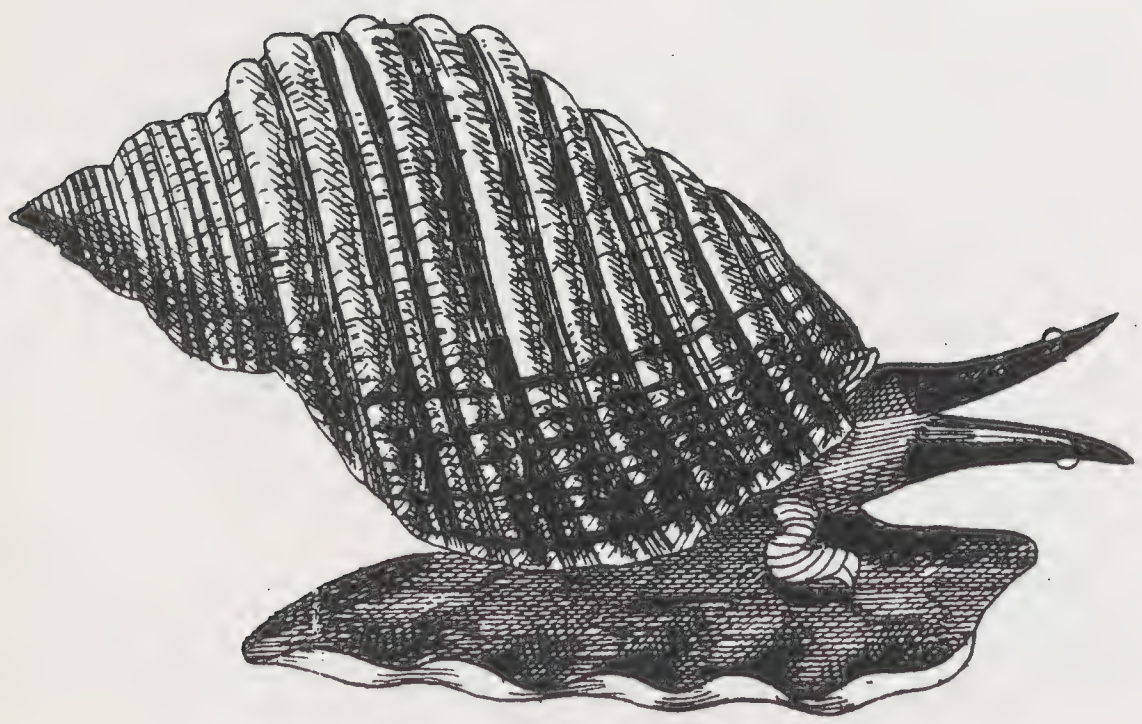
December 9, 1992







CHASMOCARCINUS ROBERTSI, A NEW CRAB SPECIES FROM THE MIOCENE OF VIRGINIA, WITH NOTES ON THE GENUS *FALCONOPLAX* (CRUSTACEA, DECAPODA, GONEPLACIDAE)

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ABSTRACT

The new species *Chasmocarcinus robertsi* from the upper Miocene Eastover Formation of Virginia is described and compared to other closely allied living and fossil representatives of this genus. The comparative morphology of fossil and living species demonstrates that the fossil genus *Falconoplax* Van Straelen, 1933, is a junior subjective synonym of *Chasmocarcinus* Rathbun, 1898. *Chasmocarcinus robertsi* occurs in, or was derived from, Miocene strata, not "?Paleocene beds" as reported by previous authors. Specimens of *C. robertsi* found near Little Cove Point, Maryland represent the northernmost known occurrence of living or fossil *Chasmocarcinus*.

INTRODUCTION

In 1961 Lauck W. Ward discovered a small fossil crab about 43 km northeast of Richmond along the south bank of the Mattaponi River, in King William County, Virginia. Subsequent field work by Ward in this and other nearby areas along the river produced more specimens which, in 1963, he sent to the National Museum of Natural History in Washington for identification. Henry B. Roberts of the museum examined these crabs and concluded that they represented a new species of the genus *Falconoplax*, which at that time was known only from the type species, *F. kugleri* Van Straelen, 1933, a crab described from and restricted to the Eocene of Falcón, Venezuela. In 1964 we began our field studies of the fauna associated with the crab-bearing lag deposits along the Mattaponi River, and supported Roberts's studies by providing him with additional crab material until his retirement in 1973. Poor health prevented Roberts from completing a number of his projects including the description of this new species of *Falconoplax*. Upon his retirement Roberts handed over that job to the senior author.

Family GONEPLACIDAE MacLeay, 1838
Subfamily CHASMOCARCININAE Serène, 1964
Genus CHASMOCARCINUS Rathbun, 1898

Chasmocarcinus RATHBUN, 1898a: 284.

Type species, by indication, *Chasmocarcinus typicus* Rathbun, 1898.

Falconoplax VAN STRAELEN, 1933: 11.

Type species, by monotypy, *Falconoplax kugleri* Van Straelen, 1933.

Definition (Modified from Rathbun, 1898a): Carapace thick, broadest posteriorly, tapering anteriorly, with lateral margins forming a curve continuous with the anterior margin. Front narrow, bilobed. Orbits marginal, oblong. Pterygostomian region with horizontal suture. Antennula with basal joint very large and hemispherical. Epistome nearly perpendicular, projecting below maxillipeds. Maxillipeds widely gaping, parallel, longitudinally placed; merus suboval, palpus articulating at antero-internal angle. Abdomen much narrower at base than sternum; third, fourth, and fifth segments coalesced in male. Sternite 8 with genital groove covered with supplementary accessory plate. Abdominal segments distinct in female. Chelipeds with merus trigonal, carpus quadrate, manus short and broad, fingers long and slender. Ambulatory legs slender, subcylindrical, third pair the longest, second next, fourth the shortest. Dactylus of last pair recurved.

The following characters should be added to Rathbun's (1898a) description of the type species of *Chasmocarcinus:* anterior dorsolateral mar-

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gin with persistent, minute tooth above prominent, V-shaped lateral groove formed by intersecting post-subhepatic and cervical grooves. These two characters are also present on the type species of *Falconoplax*.

Included Recent and fossil species:

Recent species and their type localities – *C. typicus* Rathbun, 1898a:285 (North of Trinidad); *C. obliquus* Rathbun, 1898a:286 (Bahamas, SE of Andros Isl., in Tongue of Ocean); *C. latipes* Rathbun, 1898b:602 (Mexico, Magdalena Bay); *C. cylindricus* Rathbun, 1901:10 (Puerto Rico, Mayaguez Harbor); *C. rathbuni* Bouvier, 1917:391 (Brazil, Rio Grande do Sul); *C. superbus* (Boone, 1927:16), (Belize, Glover Reef); *C. mississippiensis* Rathbun, 1931:72 (Mississippi, Mississippi Sound near Horn Island); *C. longipes* Garth, 1940:90 (Panama, Secas Ids. and Colombia, Port Utria); *C. panamensis* Serène, 1964b:258 (Bay of Panama, Isl. del Rey); *C. chacei* Felder and Rabalais, 1986:548 (northwestern Gulf of Mexico, vicinity of Flower Garden Banks).

Fossil species, their type localities and age – *C. kugleri* (Van Straelen, 1933:11), (Venezuela, central Falcón; Eocene); ?*C. bicarinella* (Collins and Morris, 1976:109), (Barbados, Spa; Eocene), type not examined. The presence of two small blunt spines bordering the cervical notch mentioned by Collins and Morris and the strong diagonal dorsal ridges seen in their figure of the holotype suggest that this species does not belong here; *C. seymourensis* Feldmann and Zinsmeister, 1984:1056 (Seymour Island, Antarctica; Eocene).

Remarks: The similarities between *Falconoplax* and *Chasmocarcinus* have, surprisingly, not been noted by previous authors. With the exception of a new species introduced by Collins and Morris in 1976, *Falconoplax* has received little attention on the generic level. However it has received considerable attention on the family level. A brief review of the literature dealing with this genus and its family placement follows.

Van Straelen (1933) erected the genus *Falconoplax* to accommodate his new fossil species *F. kugleri,* from the Eocene of Venezuela, and placed it in the family Goneplacidae without explanation. Glaessner (1969) transferred *Falconoplax* to the family Dorippidae, subfamily Tymolinae. His justification for this move was based on, among other characters, the presence of a wide sternal plate "with deep sternal grooves leading medially from 5th pereiopod coxae of female." These grooves are apparently those formed on internal molds by the dissolution of the exoskeleton, and are very misleading. Collins and Morris (1976) followed Glaessner in placing *Falconoplax* in the Tymolidae when they named a second species, *F. bicarinella,* from the Eocene of Barbados. In this paper they mentioned a third "undescribed species from the ?Paleocene of Virginia, U.S.A." Glaessner (1980), citing the criteria used by Guinot (1977,1978), stated that "it would seem necessary to exclude this genus" *(Falconoplax)* from the Tymolidae. Bailey and Blow (1987), in an abstract and without elaboration, referred to *Falconoplax* as a junior synonym of *Chasmocarcinus,* a genus in the family Goneplacidae. Glaessner and Secretan (1987) discussed and figured the genital groove present on the eighth sternite of *Falconoplax,* and retained this genus in the Tymolidae. Tavares (1992) removed *Falconoplax* from the Cyclodorippidae (= Tymolidae) and, based on the "characteristics of its thoracic sternum," stated that *Falconoplax* is related to the Goneplacidae. In this paper we repeat and explain our earlier position that *Falconoplax* is a synonym of *Chasmocarcinus* and therefore a member of the Goneplacidae.

The relationship of *Falconoplax* to *Chasmocarcinus* was called to our attention by a specimen label in the U.S. National Museum collections corrected by the late Mary J. Rathbun to read: "*Chasmocarcinus kugleri,* Van Straelen, 1933."

With Rathbun's label in mind we examined Van Straelen's types of *F. kugleri* in 1985 and compared them to the types of *C. typicus*. Both species share generic characteristics and are remarkably similar except for size. *Falconoplax kugleri* is, on the average, considerably larger than *C. typicus* and most other living representatives of *Chasmocarcinus*. However, at least one living species, *C. latipes* Rathbun, 1898, does approach the large size attained by fossil forms. Size, therefore, does not appear to be of generic importance here.

Unfortunately, Van Straelen based his description of *F. kugleri* on about 200 internal molds of carapaces. Even the figured type is completely lacking the exoskeleton. Such internal molds are misleading in the shape and surface features they present. For example, the figured type of *F. kugleri* shows a narrow front with wide orbits. Exterior exoskeleton impressions of these same features on some paratypes show their proportions to be nearly the reverse, or more like those of *Chasmocarcinus*. Similarly the tubercles, diagonal ridges, and other features described by Van Straelen (1933) for *F. kugleri* and used in part by Collins and Morris (1976) to assign *F. bicarinella* to *Falconoplax* appear stronger or more subdued than corresponding features on *Chasmocarcinus*. In summary, these surface features mistakenly led Van Straelen to believe that he had a new genus, which he named *Falconoplax*.

Our examination of the types of *F. kugleri* revealed a number of characters not presented by Van Straelen in his description of *F. kugleri*. In brief, these characters are as follows: carapace subquadrate, broadest posterolaterally. Dorsal surface covered with large punctae. Front narrow, bilobate, equal to about one-third of fronto-orbital width. Orbits marginal, ovate. Anterior dorsolateral junction defined by sharp ridge with single, minute tooth anterior to intersecting cervical groove and above lateral V-shaped groove. Epigastric lobes weak. Mesogastric and cardiac regions well defined by deep grooves. In males, sternite 8 separated from preceding by genital groove covered by supplemental sternal plate. In females, gonopores large, round, found on sternite 6. Abdomen of male broadest at segment 3; segments 3-5 fused. Abdomen of female broadly oval, segments unfused, distinct. Right and left carpus of female chelipeds with long, acute spine.

These *Falconoplax* characters, in combination with those mentioned by Van Straelen, describe a crab which falls well within Rathbun's definition of *Chasmocarcinus*. In conclusion, the number of shared generic characteristics and overall similarities of these two genera compel the present authors to consider *Falconoplax* a junior subjective synonym of *Chasmocarcinus*.

CHASMOCARCINUS ROBERTSI, n. sp.
Plate 1, figures 3-5;
Plate 2, figures 3-12.

An undescribed species from the ?Paleocene of Virginia, U.S.A. COLLINS and MORRIS, 1976, p. 112; TAVARES, 1992, p. 73.

Diagnosis: Carapace large, thick, subquadrate in dorsal outline; anterior dorsolateral junction with granulated ridge; dorsal and ventral surfaces coarsely punctate; fingers of male major chela very long, slender, greatly deflected, proximal end of propodus with row of five distinct teeth, first and fifth prominent; carpus in both sexes with stout curved spine on inner angle; eighth sternite of male with genital groove covered by accessory plate.

Description: Carapace large, thick, subquadrate in dorsal outline, broadest at posterolateral angle, anterior third of dorsal surface strongly deflexed, level transversely. Anterolateral margins perpendicular. Subhepatic region smooth to sparsely granulate, moderately inflated with broad smooth furrow below; dorsolateral juncture above well defined by granulated ridge. Ridge with single, persistent, minute tooth anterior to intersecting cervical groove. Front narrow, bilobate, projecting beyond anterolateral margin, roughly equal to one third of fronto-orbital width. Lobes rounded, surface densely dentate, borders defined by raised thickened smooth to striate lip. Orbits transverse, in low relief laterally, ovate with broad granulate lower and lateral inner rim; border striate above, coarsely granulate below and laterally; distal orbital rim in contact with weakening dorsolateral ridge. Suborbital margin extending well beyond front. Dorsal surface coarsely punctate and granulate. Punctae developed into deep, transverse furrows near anterior and posterior borders; surface finely granulate anteriorly. Epigastric lobes weak. Cervical groove usually faint dorsally, occasionally strong with intermittent deep depressions, always strong laterally where it terminates to form a prominent V-shaped groove with post-subhepatic groove joining inferior horizontal groove below. Posterior gastric pits very small, slit-like. Mesogastric and cardiac regions well defined by deep grooves, surfaces finely granulate. Diagonal, low, narrow transverse branchial ridge intersects lateral margin medially, separated from incurving terminus of anterior dorsolateral ridge by cervical groove. Branchial regions, greatly expanded, sloping posterolaterally to form broad flange; surface coarsely granulate, rugged, with deep pits and furrows. Finely corrugated, narrow, raised cord along posterolateral border.

Eyestalks visible along their entire length when retracted, slightly incurved, robust, filling orbits at base, tapering distally to (inferred) small cornea, upper surface punctate with few granulations. Antennules prominent; basal arti-

cle very large, hemispherical; second article very long; third article and flagellum not seen. Antennal peduncle seated in orbital gap. Operculum of excretory pore broad, ovate. Epistome with large, anterior, medially placed, badly eroded bilobate prominence. Outline and other features incomplete. Buccal frame broadly rectangular. Third maxillipeds widely gaping; merus broadly suboval, width slightly more than ischium; palpus articulating at antero-internal angle; endopod extending to merus medially. Pterygostomian region broadly triangular, bordered by low, narrow, smooth lip; surface smooth to sparsely punctate, with low pustules.

Sternum greatly arched longitudinally; surface coarsely punctate and granulate. Punctae large, evenly distributed, occasionally drawn into long furrows on sternite 4. Granules fine, evenly distributed over most sternites, coarse and concentrated to form longitudinal ridges adjacent to abdominal depression and along posterior margin of sternites 4-8, occasionally developed into striae adjacent telson in old males, coarsest in mature individuals of both sexes. Sternites 5-8 coarsely beaded along anterior margins. In males, sternite 8 broad, separated from preceding by genital groove covered by supplemental sternal plate. In females, gonopores large, round, with simple low rim, found on sternite 6 impinging border of sternite 5. Sternite 8 with broad, shallow transverse depression. Abdomen of male narrow, broadest at segment 3, finely granulate, sometimes wrinkled. Segment 1 not seen; segment 2 narrow; segments 3-5 fused, usually depressed medially at sutures; lateral extension of segment 3 covering mesial ends of supplementary sternal plates; segment 4 with or without lateral tubercle. Segment 6 nearly equal in length to telson, with or without two medial transverse slit-like pits, anterolateral margins distinctly elevated. Abdomen of female broadly oval, finely granulate, with longitudinal furrows on segments 3-7. Lateral margins of segments 3-6 coarsely granulate. Segment 4 widest; segment 6 longest, reniform. Telson broadly triangular with weak medial longitudinal ridge.

Chelipeds long, unequal in both sexes, surfaces punctate, for the most part smooth. Merus short, heavy, with fine granules along inferior edge; carpus subrectangular with stout, curved, granulated spine on inner angle. Inner carpal border finely granulate. In males palm of major chela short, inferior surface broadly triangulate,

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PLATE 1

Figures

1-2. *Chasmocarcinus typicus* Rathbun
North of Trinidad; Recent.

1a. Male syntype, in dorsal view, cl 7.7 mm, cw 10.4 mm (USNM 6901). Scale = 1 mm.

1b. Male syntype above, in ventral view to show genital groove and covering plate on left thoracic sternite 8. Scale = 1 mm.

2. Male syntype, left frontal lobe and orbit in anterior view, cl 8.0 mm, cw 10.4 mm (USNM 6901). Scale = 0.5 mm.

3-5. *Chasmocarcinus robertsi* Blow and Bailey, n. sp.
King William Co., Virginia; Miocene.

3. Female holotype, in dorsal view, cl 17.9 mm, cw 24.5 mm (USNM 468599).
Locality: USGS 26619. Arrow points to minute tooth on anterior dorsolateral ridge.
Scale = 3 mm.

4. Female paratype, right frontal lobe and orbit in anterior view (image reversed), cl 16.7 mm, cw (approximate; carapace broken) 23.2 mm (USNM 468600).
Locality: USGS 26620. Scale = 1 mm.

5. Male paratype, in ventral view to show genital groove and covering plate on left thoracic sternite 8. Apparent opening on ventral surface between plate cover and sternite 8, abnormal. Dorsal aspect of carapace concealed by matrix. Width of sternum 21.5 mm (USNM 468601).
Locality: USGS 26623. Scale = 1 mm.

6-8. *Chasmocarcinus kugleri* (Van Straelen)
Falcón, Venezuela; Eocene.

6a. Female holotype internal mold, in dorsal view, cl 18.8 mm, cw 23.3 mm (NHMB F 1290). Scale = 3 mm.

6b. Female holotype above, left frontal lobe and orbit in anterior view. Scale = 1 mm.

7. Male paratype internal mold, in ventral view to show genital groove and covering plate on left thoracic sternite 8, cl (approximate) 14.3 mm, cw 18.3 mm (NHMB F 1435). Scale = 1 mm.

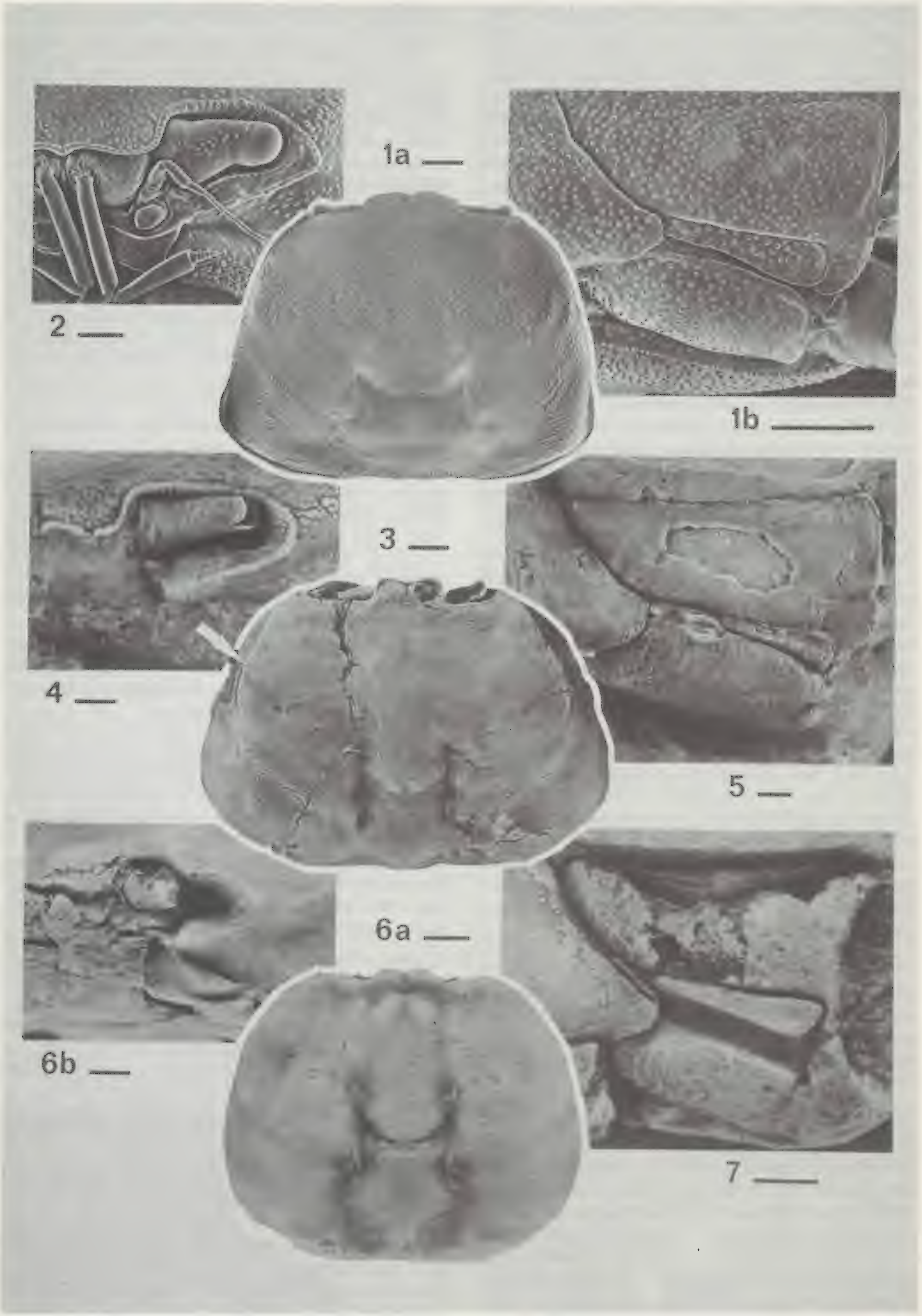

PLATE 1

height greatest at insertion of dactyl. Outer face of palm with narrow sulcus posteriorly, inferior outer angle smooth to striate. Fingers long and very slender, slightly deflected in young males, greatly deflected downward and curved inward to fit arch of sternum in gerontic males; fingers extending to posterior border of sternum. Proximal end of fixed finger with row of five distinct teeth, first and fifth prominent, set in opposition to small blunt denticules on dactylus above. Dactyl shorter than fixed finger, broad at base, superior surface weakly granulate. Distal portions of both fingers with minute acute teeth, tips of each bent inward. Palm of minor chela slightly smaller then major, of similar shape, outer surface without posterior sulcus; palm and fixed finger nearly equal in length, opposable margins with minute acute teeth distally; fixed finger slender, broad proximally, with scythe shaped gape at base in opposition to small, blunt denticules on dactyl above. Dactyl incomplete. In females, palm of major chela slightly larger than minor, shape like that of male, outer surface with posterior sulcus; fingers slightly longer than palm, of equal length. Dactyl very broad at base, superior surface weakly granulate. Fixed finger with series of blunt denticules along proximal third, in opposition to series of smaller denticules on dactyl above. Dactyl with strong tooth at base. Distal portions of both fingers with minute acute teeth. Minor chela incomplete, fingers more slender than those of major chela. Fixed finger with scythe shaped gape at base, margins of opposition of both fingers with fine teeth. Walking legs incomplete. Meri of walking legs long, moderately compressed, with perpendicular rows of granules on lateral surfaces. Merus of leg 3 appears longest; merus of leg 4 shortest.

Measurements in millimeters: cl = carapace length, measured along midline; cw = carapace width, measured at maximum distance between posterolateral borders.

Size: Female range: cl 14.6 mm to 20.5 mm, cw 18.2 mm to 28.5 mm. Male range: cl 14.3 mm to 19.5 mm, cw 18.0 mm to 26.9 mm. Largest male: cl 29.1 mm, estimate, cw not available, carapace enclosed in matrix. Largest specimen (sex indeterminate): cw 31.6 mm. Measurements based on 113 specimens.

Material and Repositories: Of the 317 specimens of *C. robertsi* examined in private and museum collections, the holotype, 34 paratypes and 26 non-types are deposited in the U.S. National Museum of Natural History (USNM). In addition 12 paratypes, in lots of 3, have been deposited in the Virginia Museum of Natural History, Martinsville, Virginia (VMNH); Natural History Museum, Basel (NHMB); British Museum (Natural History), London (BMNH); and Muséum National d'Histoire Naturelle, Paris (MNHN).

Holotype: Female (USNM 468599), cl 17.9 mm, cw 24.3 mm.

Type locality: USGS 26619, White Oak Lodge and Landing, right bank Mattaponi River, King William Co., Virginia. Collected *in situ* in the Claremont Manor Member of the Eastover Formation; Miocene.

Paratypes: 4 males and 1 female (USNM 468606, 468611, 468620-468622), USGS 25274, White Oak Lodge and Landing, beach spoil, Ward Collection; 4 males and 3 females (USNM 468602, 468604, 468616, 468617, 468623-468625), USGS 26619, White Oak Lodge and Landing, collected *in situ* in the Claremont Manor Member of the Eastover Formation; 5 males and 3 females (USNM 468600, 468603, 468607, 468615, 468626-468629), USGS 26620, White Oak Lodge and Landing, beach spoil; 1 male and 1 female (USNM 468609, 468630), USGS 26622, high bluffs just down river from White Oak Lodge and Landing, collected *in situ* in the Claremont Manor Member of the Eastover Formation; 3 males and 2 females (USNM 468601, 468605, 468613, 468618, 468631) USGS 26623, high bluffs just down river from White Oak Lodge and Landing, beach spoil; 4 males and 3 females (USNM 468608, 468610, 468612, 468614, 468619, 468632, 468633) USGS 26625, a mixture of beach spoil from USGS 26619-26623.

Of the 34 paratypes listed above, 7 males and 6 females (USNM 468600-468612) are measured and figured in this paper. Their measurements are as listed on the plate captions.

Many of the morphologic characters noted in the description of *C. robertsi* are rarely observed on more than one specimen. For that reason the paratypes have received individual USNM catalogue numbers and should be kept together.

Etymology: This species is named for the late Henry B. Roberts, of the U. S. National Museum, who stimulated and guided the authors' early interest in fossil decapods.

Discussion: In terms of size and shape *C. robertsi* appears closely allied to *C. kugleri*, from which it differs in possessing a broader, more granulated orbital rim, a shorter, more robust spine on the inner angle of the carpus of the chelipeds, and a considerably larger and more deflected male chela.

A series of paratypes (NHMB F 1426 - F 1436) of *C. kugleri*, which exhibit a number of characters not mentioned by Van Straelen (1933), were isolated, prepared, and photographed by the authors in 1985. One of these specimens, a female (NHMB F 1434) shows a long acute spine on the

inner angle of the carpus of both chelipeds quite unlike that described for *C. robertsi* above.

Chasmocarcinus robertsi most closely resembles the Recent species *C. typicus* and to a lesser degree, *C. latipes*. It is, however, considerably larger than *C. typicus* but not that much larger than *C. latipes*. Measurements given for the type of *C. latipes*, cl 12.5 mm, cw 17.8 mm, approach the size range stated for *C. robertsi*. The carapace of *C. robertsi* is far more punctate than that of *C. typicus*, and the punctae of *C. robertsi*, unlike those of *C. typicus*, are large and often drawn into deep furrows. The right male chela of both *C. robertsi* and *C. typicus* are very large and greatly deflected but differ dramatically in the dentition found on each. Five distinct teeth, first and fifth prominent, are found at the proximal end of the propodus of *C. robertsi* while, in contrast, a crest of minute acute teeth is found at this same position on *C. typicus*. Like the carapace of *C. robertsi*, that of *C. latipes* is very punctate, and has a distinct, granulated, anterior dorsolateral ridge. A minute tooth found along this ridge and the V-shaped lateral groove below are, however, much weaker on *C. latipes*. The orbital rim of *C. latipes* though shaped much like *C. robertsi*, is not as broad. The chelipeds of male *C. latipes*, unlike those of *C. robertsi*, are equal.

In combination, the large size of the carapace, its anterolateral granulated ridge, raised ovate broad rimmed orbits, short, stout, curved granulated spine on the inner angle of the carpus of the chelipeds in both sexes, and the very large, curved male major chela easily separate *C. robertsi* from all other living and fossil species of *Chasmocarcinus*.

Localities: VIRGINIA: Mattaponi River, left bank at Locust Grove and Rickahock, King and Queen County, and right bank at and below White Oak Lodge and Landing (type locality), King William County. Potomac River, right bank, beach spoil above old mill at Stratford Hall, Westmoreland County. MARYLAND: Chesapeake Bay, western shore, beach spoil at Chesapeake Bay Ranch Club south of Little Cove Point, Calvert County.

Age and Stratigraphic Distribution: Upper Miocene: Claremont Manor Member of Eastover Formation and ?Windmill Point Member of St. Marys Formation. Occurrence in above units known from Mattaponi River, Virginia, to Little Cove Point, Maryland. *In situ* specimens have been found only at localities along the Mattaponi River where 97% occur in the basal unit of the Claremont Manor Mbr. of the Eastover Fm. Shapes, borings, and surface textures of Eastover crab nodules containing *C. robertsi* suggest that most were derived from discontinuous underlying beds of the Windmill Point Mbr., St. Marys Fm. Two unreworked specimens were found at Locust Grove on the Mattaponi River *in situ* in beds below the Eastover thought to be St. Marys. *Chasmocarcinus robertsi* is thus far restricted to localities that fall within an area where the basins of deposition of the St. Marys and Eastover Fms. overlap (see Ward and Powers, 1989). A section and discussion of stratigraphy at the type locality at White Oak Landing is presented by Ward (1992).

The ?Paleocene age suggested by Collins and Wright (1976, p. 112) and repeated by Tavares (1992, p. 74) is unsubstantiated and incorrect. It also should be noted that specimens of *C. robertsi* from the type locality have been offered for sale since at least 1966 by Malick's Fossils of Baltimore, Maryland. Malick listed this crab in his catalogues under several names, ages, and localities, including "*Falconoplax* sp., undescribed, Paleocene, Aquia [Fm.], King William County, Va." Decades of fieldwork in the Coastal Plain strata of Virginia and Maryland by the authors, L.W. Ward, and others have yielded specimens of *C. robertsi* only from Miocene beds.

Taphonomy and Paleoecology: Specimens of *C. robertsi* are found as compacted, articulated individuals in reworked, bored, carbonate-apatite nodules. In general, these crabs are remarkably complete with most exhibiting intact dorsal and ventral aspects of the carapace with abdomens in place. Eye stalks, antennae, antennules, maxilla, and complete outer maxillipeds are often present, though usually covered by matrix. Paired chelae are common in both males and females and are always found folded and crossed close to the ventral surface of the carapace. Incomplete meri of walking legs

are often present. The completeness of these crabs, their subcylindrical shape, and the folded nature of their fragile chelae suggest that they were probably buried alive in burrows. This fossil species seems to have preferred a muddy bottom habitat, as do most of the 10 known Recent species. A sparse assemblage of decapods is found with *C. robertsi*. Of the 307 fossil decapods found in Miocene strata along the Mattaponi River since 1964 by the authors and others (excluding Ward), only 27 specimens represent species other than *C. robertsi*. Specimens of *C. robertsi* and

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PLATE 2

Figures

1. *Chasmocarcinus typicus* Rathbun
   Male syntype, anterior outline in dorsal view, cl 8.0 mm, cw 10.4 mm (USNM 6901).
   Locality: North of Trinidad; Recent. Scale = 1 mm.
2. *Chasmocarcinus kugleri* (Van Straelen)
   Paratype, sex indeterminate, anterior outline of exoskeleton impression in dorsal view, cl 17.3 mm, cw 21.7 mm (NHMB F 1426)
   Locality: Falcón, Venezuela; Eocene. Scale = 2 mm.

3-12. *Chasmocarcinus robertsi* Blow and Bailey, n. sp.
   King William Co., Virginia; Miocene.

3. Male paratype, anterior outline in dorsal view, cl 18.1 mm, cw 23.3 mm (USNM 468602).
   Locality: USGS 26619. Scale = 2 mm.
4. Male and female paratypes, composite drawing, to show left third maxilliped. Male carapace incomplete, width of sternum 19.5 mm (USNM 468603)
   Locality: USGS 26620.
   Female, cl 19.6 mm, cw 25.0 mm (USNM 468604).
   Locality: USGS 26619. Scale = 1 mm.
5. Female paratype, sternum flattened to show complete outline and large female opening on sternite 6, cl 18.1 mm, cw 23.4 mm (USNM 468605).
   Locality: USGS 26623. Scale = 2 mm.
6. Female holotype (USNM 468599) and paratype, composite drawing, abdomen flattened to show complete outline. Paratype, cl 15.6 mm, cw 21.0 mm (estimate) (USNM 468606).
   Locality: USGS 25274. Scale = 2 mm.
7. Male paratype, sternum flattened to show complete outline and genital covering plate on sternite 8, cl 17.0 mm, cw 22.9 mm (USNM 468607).
   Locality: USGS 26620. Scale = 2 mm.
8. Male paratype, abdomen flattened to show complete outline. Dorsal aspect of carapace concealed by matrix. Width of sternum 21.5 mm (USNM 468601).
   Locality: USGS 26623. Scale = 1 mm.
9. Female paratypes, composite drawing, right carpus and chela in external view:
   (1) cl 18.5 mm, cw 27.5 mm (USNM 468608).
   Locality: USGS 26625.
   (2) cl 18.5 mm, cw 22.2 mm (USNM 468609).
   Locality: USGS 26622. Scale = 2 mm.
10. Male paratype, left chela in external view, cl (approximate) 17.0 mm, cw 23.0 mm (USNM 468610).
    Locality: USGS 26625. Scale = 2 mm.
11. Male paratype, right chela of young male in external view, cl 14.5 mm, cw 20.4 mm (USNM 468611).
    Locality: USGS 25274. Scale = 2 mm
12. Male paratype, (a) right chela of gerontic male in external view. Carapace concealed by matrix. (b) right cheliped of gerontic male, carpus and chela in dorsal view (USNM 468612).
    Locality: USGS 26625. Scale = 2 mm.

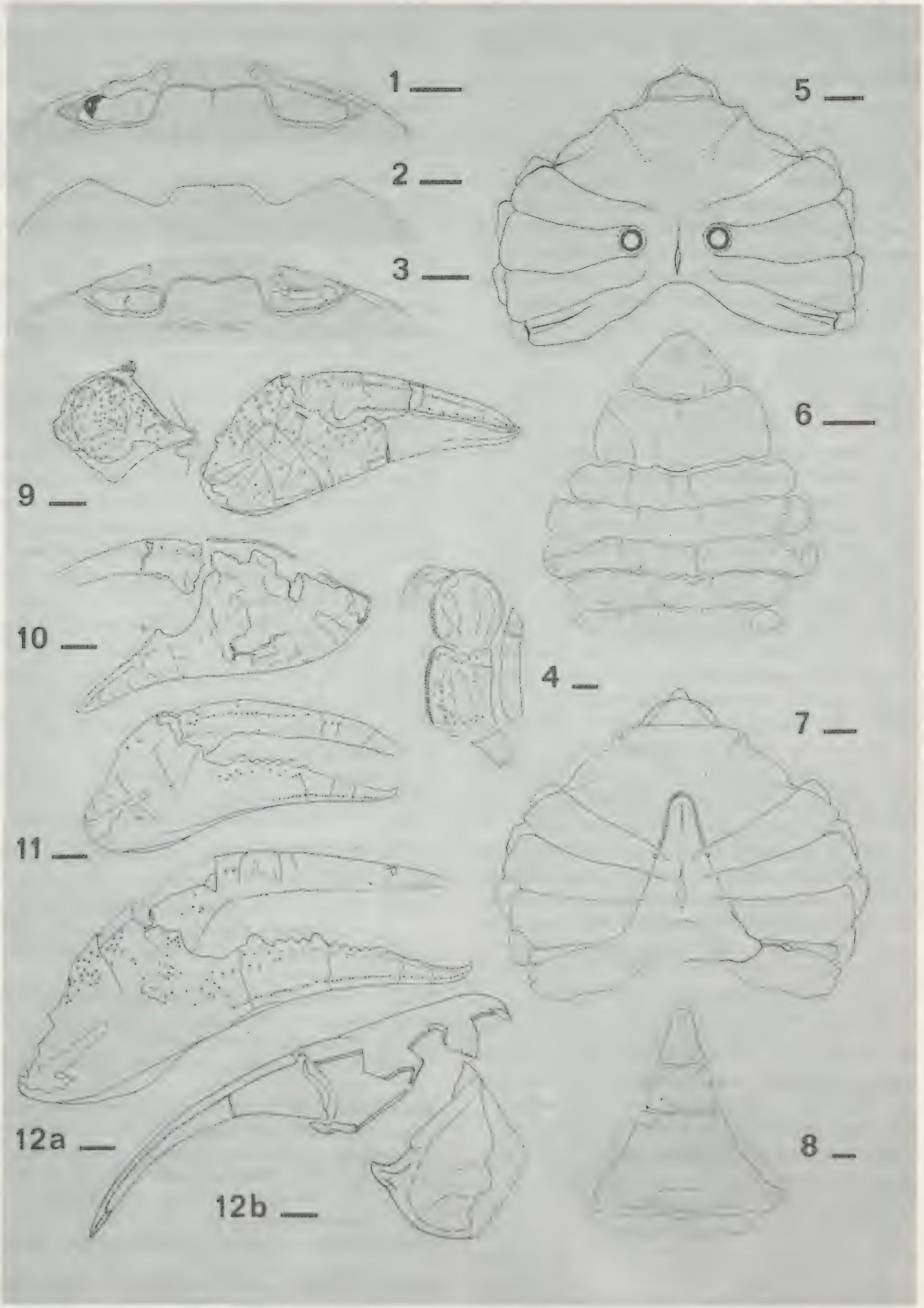

PLATE 2

Cancer sp., in unreworked nodules, co-occur in beds of probable St. Marys age along the Mattaponi River at Locust Grove. At the type locality, White Oak Landing, reworked nodules collected as beach spoil contain *C. robertsi, Cancer* sp., ?*Libinia* sp., *Callinectes* sp., ?*Calappa* sp., ?*Necronectes* sp., *Archeoplax signifera* Stimpson, 1861, *Callianassa* sp., and a pagurid. Williams (1974) examined specimens of *Callinectes* from the Mattaponi localities but due to their poor state of preservation could not determine species.

North of the Mattaponi River where the Eastover and St. Marys basins overlap, two specimens of *C. robertsi* were found as beach spoil along the Potomac River where both formations are exposed, and a number of highly abraded phosphatic nodules with *C. robertsi* were found as beach spoil along the shores of Chesapeake Bay near Little Cove Point, Maryland. No *C. robertsi* has been found in the extensive Eastover outcrop area south of the Mattaponi River. In these basal Eastover beds *Archeoplax signifera* is by far the most abundant fossil decapod. In marked contrast to the somewhat limited known distribution of *C. robertsi, A. signifera* has an extensive geographic range in Miocene strata of the Atlantic Coastal Plain. It occurs in the Salisbury Embayment, at Petersburg, Virginia, north to Little Cove Point, Maryland. Farther to the north, *A. signifera* is found near the northern edge of the Raritan Embayment, in glacially deformed strata on Martha's Vineyard, Massachusetts. *Chasmocarcinus* has not been reported from the Raritan Embayment.

ACKNOWLEDGMENTS

We are particularly indebted to Lauck W. Ward, of the Virginia Museum of Natural History, Martinsville, Virginia, for his discovery of *Chasmocarcinus robertsi,* for making his material available to us for study, and for his continuing help with Virginia stratigraphy. We are also especially indebted to the late Henry B. Roberts, who first determined this species to be new, for releasing his material to us for study.

Access to the river and fossil exposures on their respective properties was provided by the late Benjamin Garrett and his nephew John Garrett of King William, Virginia, and John Walker, and Mr. and Mrs. William Ellwanger of Walkerton, Virginia. We gratefully acknowledge their assistance without which this paper would not have been possible.

We thank Peter Jung and René Panchaud of the Natural History Museum of Basel (Switzerland) for the loan of type specimens of *C. kugleri.*

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Raymond B. Manning, Thomas R. Waller, and Barbara A. Bedette, read the manuscript and made very helpful suggestions for its improvement. Carolyn Harrington assisted in the preparation of the illustrations.

LOCALITY DATA

The following are U.S. Geological Survey locality numbers:

USGS 25274: White Oak Lodge and Landing, right bank Mattaponi River, King William Co., Va. Beach spoil. L.W. Ward collection.

USGS 26619: Locality as above. Material collected *in situ* from the Claremont Manor Mbr. of the Eastover Fm.

USGS 26620: Locality as 26619 above. Beach spoil.

USGS 26622: High bluffs along right bank Mattaponi River, just down river from White Oak Lodge and Landing, King William Co., Va. Material collected *in situ* from the Claremont Manor Mbr. of the Eastover Fm.

USGS 26623: Locality as 26622 above. Beach spoil.

USGS 26625: A mixture of beach spoil from localities 26619 - 26623 above, and possibly the beaches below the community of Rickahock on the left bank Mattaponi River, King and Queen, Co., Va.

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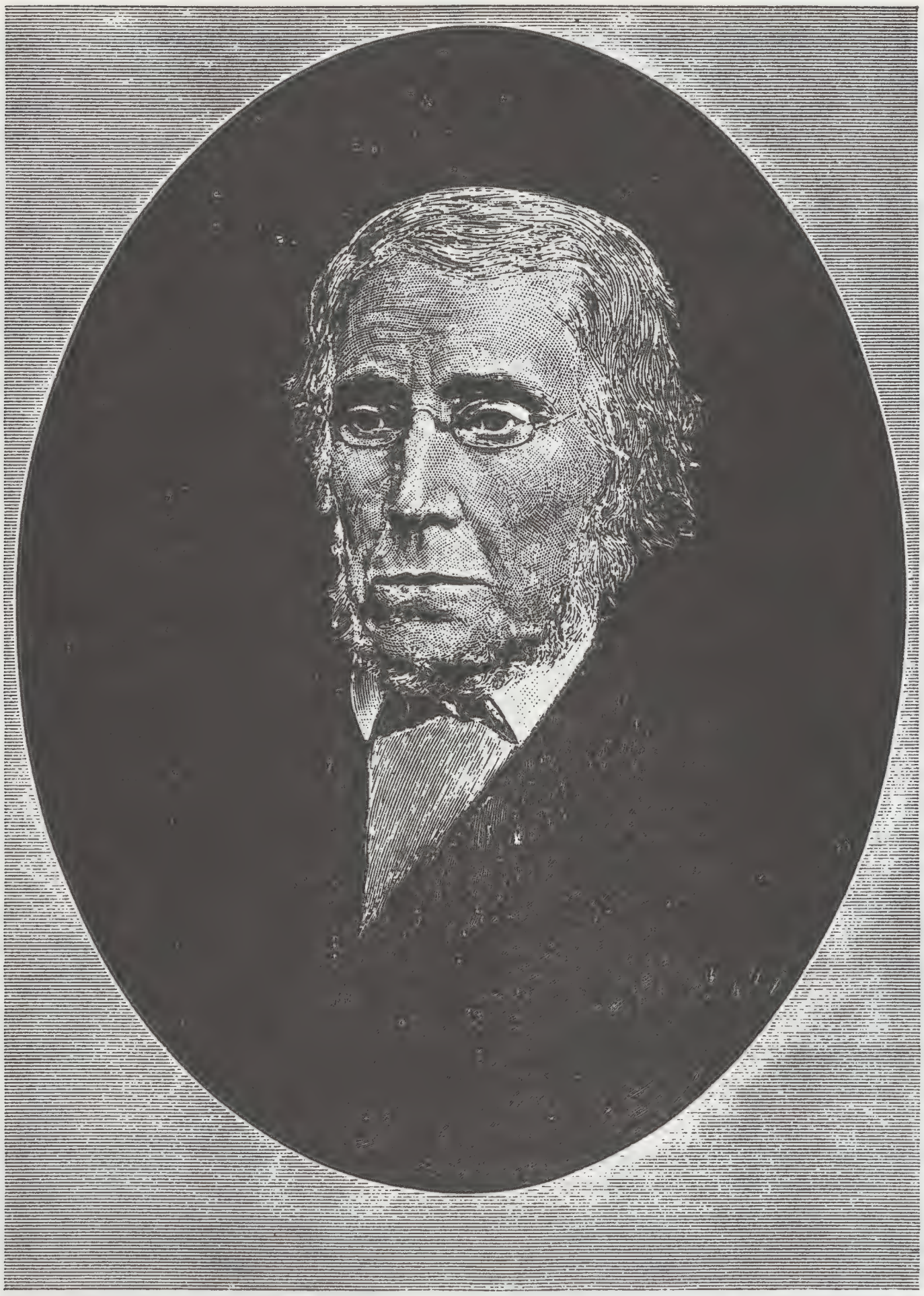
December 9, 1992



VIGNETTES OF COASTAL PLAIN GEOLOGY

TIMOTHY ABBOTT CONRAD
(1803-1877)

If anyone can be called the Father of Coastal Plain Geology, it is Timothy Abbott Conrad. He was a perceptive paleontologist who almost single-handedly established the Tertiary formations of the Atlantic and Gulf Coastal Plains, as distinguished by their fossils. In his pioneering works on the region he named nearly 1000 Cenozoic species, so it is little wonder that any paleontological study of the Coastal Plain necessarily begins with his work. And yet through it all he was a shy, almost reclusive, moody, unhappy man, who rarely held any type of paid position for very long. His carelessness was notorious, and toward the end of his life he suffered from a loss of memory that finally caused him to give up work all together. In spite of this he figured substantially in the paleontological literature of the United States for over 50 years, producing an aggregate of some 1700 published pages and 300 plates, most of which he prepared on lithographic limestone himself. (*From* H.E. Wheeler, 1935, Bulletins of American Paleontology, v. 23, no. 77)

A SECOND CRETACEOUS MURICID FROM THE GULF COASTAL PLAIN

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*MUNICH, GERMANY**

The author (Garvie, 1991) described the first Cretaceous muricid species *Poirieria (?Paziella) cretacea* in the New World, from the Kemp Clay (Maastrichtian) of Texas, so it was with particular satisfaction that a second muricid species was discovered in the Coffee Sand (Campanian) of Mississippi. The author, his wife, and David T. Dockery of the Mississippi Geological Survey collected bulk samples from the fossiliferous bed "E'"in the Tupelo Tongue of the Coffee Sand; the specimen was subsequently discovered after disaggregation and screening of the sediment. The reader is referred to Dockery (1990) and Sohl (1964b) for a discussion of the geology of the Coffee Sand. Nannoplankton and ammonites indicate the age of the fauna to be Early/Middle Campanian in the American sequence. To date *P. cretacea* and the renamed species *Poirieria (?Paziella) cenomae* Garvie, 1991, from Saxony in eastern Germany, were the only definite Cretaceous muricids known.

An examination of the Cretaceous collections in the British Museum (Nat. Hist.) has revealed one further Cretaceous muricid; this specimen (G 65579) labelled *Murex*(?) sp. is from the Providence Shales (Campanian) of Jamaica. The specimen, although very poorly preserved, shows four or five spines and is quite similar in size and shape to *P. cretacea* and should probably be assigned to the same genus s.l. If the age of the Jamaican specimen is indeed Campanian, the *Poirieria* stock is much older than previously believed and shows remarkably little change over time.

Several authors have assigned Cretaceous species to the Muricidae, particularly in the 19th century when the science of taxonomy was less discerning than it is today. Most fusoid species with spines and a denticulate inner surface of the outer lip were erroneously assigned to either *Murex*, *Triton*, or *Tritonium*. The majority of these would now be placed within the Cymatidae. Other genera which have been placed in the Muricidae include: *Pyrifusus* in Meek (1876), now placed in the Melongenidae: *Sargana* and *Lowenstamia* in Wade (1926), now in the Cancellariidae and Ficidae respectively; and *Triton* or *Tritonium* (Pictet and Campiche, 1858-60; Binkhorst, 1861; and Zekeli, 1852), now in the Cymatidae. In the earlier Woodbine fauna of Texas (Cenomanian), monographed by Stephenson (1952), Muricidae are absent and there are only three species in the related family Fusinidae.

The writer is indebted to David T. Dockery, III for encouragment to describe this Cretaceous muricid, particularly as he is in the process of monographing the remaining Coffee Sand molluscan fauna. Thanks also go to John Cooper, Noel Morris and Paul Jeffery at the British Museum (Natural History) for access to the collections and the use of microscopes and other facilities. Particular thanks go to Emily H. Vokes for her invaluable review.

Phylum MOLLUSCA
Class GASTROPODA Cuvier, 1797
Subclass PROSOBRANCHIA
Milne-Edwards, 1848
Order NEOGASTROPODA Wenz, 1938
Superfamily MURICACEA Rafinesque, 1815
Family MURICIDAE da Costa, 1776
Subfamily MURICINAE da Costa, 1776
Genus POIRIERIA Jousseaume, 1880

Poirieria JOUSSEAUME, 1880, Le Naturaliste, Année 2, no. 42, p. 335.

Type species: *Murex zelandicus* Quoy and Gaimard, 1833, by original designation.

Subgenus PANAMUREX Woodring, 1959

Panamurex WOODRING, 1959, U.S. Geol. Surv., Prof. Paper 306-B, p. 217.

Type species: *Murex gatunensis* Brown and Pilsbury, 1913, by original designation.

POIRIERIA (? PANAMUREX) DUOCLAVUS
Garvie, n. sp.
Text-figure 1

Description: Shell small, broadly fusiform, tip of spire broken, 3 1/2 strongly carinated whorls remaining. Earliest whorl with 12 ribs, body whorl with nine, the ribs diminishing in size towards impressed suture and canal. On the carina ribs developing into low transversely flattened nodes, which in two places on the body whorl become foliated spines. Spiral sculpture

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overriding the axial, consisting of four weak cords on the shoulder, one strong one on the carina, two similarly strong ones below. Body whorl with the three original cords on the shoulder, nine stronger cords below, and three additional weaker lines, two of them margining the carinal cord, one at the start of the canal. Suture impressed, moderately swollen below. Surface smooth and polished. Between carinal nodes, lines of growth abaperturally broadly U-shaped and centered on the carina; on nodes narrowly U-shaped; on larger spine behind the lip and vestigial spine on opposite side of the body whorl strongly pulled back into a narrow V. Aperture moderately large, anal sulcus broad, outer lip serrate and open into the final spine. A short distance behind the outer lip, the shoulder thickened and varix-like, however not continuing on below the carina. Labrum with six strong denticles. Labium posteriorly with two lirae and one weak denticle; anteriorly with four elongated denticles. Siphonal fasciole strong, canal short, narrow and twisted towards the left.

Dimensions of holotype: height 49.2 mm, diameter (including spines) 30.2 mm.

Holotype: USNM 465512.

Type locality: Griffin sandpit, bed E, "Friendship Locality," east of Chapelville, Lee County, Mississippi (*fide* Nolf and Dockery, 1990).

Occurrence: Coffee Sand, Cretaceous (Campanian age).

Discussion: The strong spiral sculpture, basal denticles on the inner lip and denticles on the interior of the outer lip are all characteristic of *Panamurex*. Prior to this report the oldest known *Panamurex* was *P. macneili* Vokes, 1970, from the Oligocene of Mississippi. The lirae on the posterior end of the labium are not seen on any Tertiary species of Muricinae; this feature and the long time interval between the Campanian and the Oligocene is cause for the questionable assignment to *Panamurex*.

Just recently, Vokes (1992) has described several species of *Panamurex* from the U.S. and Caribbean area of which *Poirieria (Panamurex) gibsonsmithi* shows the strongest resemblance to *P. duoclavus*, remarkable considering the long time interval between the two.

A few Cretaceous species previously assigned to the Muricidae might be considered for a comparison with *P. duoclavus*. Pictet (1854-73) assigned four species to *Murex* and one to *Triton*. Most of his species are internal steinkerns and so impossible to assign with any confidence, and those with remaining external sculpture would be assigned today to the Cymatidae. In any case none of those species shows any resemblance to *P. duoclavus*. *Triton koninckí*, from the Maastrichtian at Limbourg, figured in Binkhorst (1861), is better placed in *Ranella*.

From the Turonian Cretaceous of Gosau, Zekeli (1852) described *Tritonium gosauicum*, a broadly fusoid species with an elongated aperture, labral denticles, a strong anal notch and a short canal. Stoliczka (1867) believed this should be assigned to *Simpulum* (= *Monoplex* Perry, 1811) but is near *Sassia*. A closer species, and possible muricid, is *Tritonium gravidum* Stoliczka, 1867, from the Arialoor Cretaceous of southern India. This species, described from imperfect material, has rounded whorls, short spines, varices spaced two-thirds of a whorl apart and a sculpture of dense striations between the stronger lines; its exact placement must await a closer examination. From California, Gabb (1864) described four species of *Tritonium* from the Cretaceous, all of which are now known to come from the Eocene. Stewart (1926) revised Gabb's species and reassigned *T. whitneyi* to *Murex* s.l., which Vokes (1971) placed questionably in *Hexaplex*. This species shows greater similarity to *P. duoclavus* than the preceeding, although it is more elongated and has a prominent doubly noded periphery.

Poirieria (?Panamurex) duoclavus does appear to have a marked similarity to *Tritonium univaricosum* Wade, 1926, known only from the Ripley Formation of Coon Creek, Tennessee. Sohl (1960) figured a hypotype and placed the species doubtfully in *Charonia*, due partially to a lack of good material. Sohl had four incomplete specimens, the largest of which he estimated at 50.0 mm; his figure, as well as Wade's original figure shows a small spine on the apertural carina. The author has a specimen that is complete except for a worn protoconch, 87.3 mm in height, where the spine is proportionately more developed. Aside from the differing whorl shapes and relative strength of the spiral sculpture the following can be observed: in *T. univaricosum* the shape of the growth lines is essentially the same whether they run over the varicose ribs, the spaces between them or over the single spine. In *P. duoclavus* however, the growth lines are abapturally pulled back from the aperture

over the two spines and to a lesser extent on all the ribs; this allows the animal to place the entire aperture very near to the ground. All species of Muricidae have this feature to a greater or lesser extent. The labral features also differ between the two species; *T. univaricosum* has a strong ridge margining the columella but *P. duoclavus* has a few short denticles, a feature also shown by *Hexaplex (H.) texanus* Vokes, 1968 and characteristic of *Panamurex* Woodring, 1959. Were the species somewhat shorter and without the spinal process, *T. univaricosum* could easily be assigned to a subgenus of *Hydrotribulus*, a genus that Sohl (1964a) assigns to the Olividae!

Paradoxically, *P. duoclavus* appears to be more closely related to *P. (Paziella) harrisi* Vokes, 1970, from the Porters Creek Formation (Paleocene) than to the similar, but Late Cretaceous *P. cretacea* from the Kemp Clay. One could easily surmise *P. duoclavus* to be the ancestor of *P. harrisi* by a reduction in its spiral ornamentation, the loss of the labial dentition and a transformation of the rounded ribs into varices.

As to a precursor of *P. duoclavus*, the similarities to species of *Buccinopsis* from the Coffee Sand and Ripley Formation are suggestive of a common but distant ancestor. The Coffee Sand species is interesting in that it suggests that the early development of the muricid varicial spines first occurred in the adult and only chronologically later in the juvenile stage.

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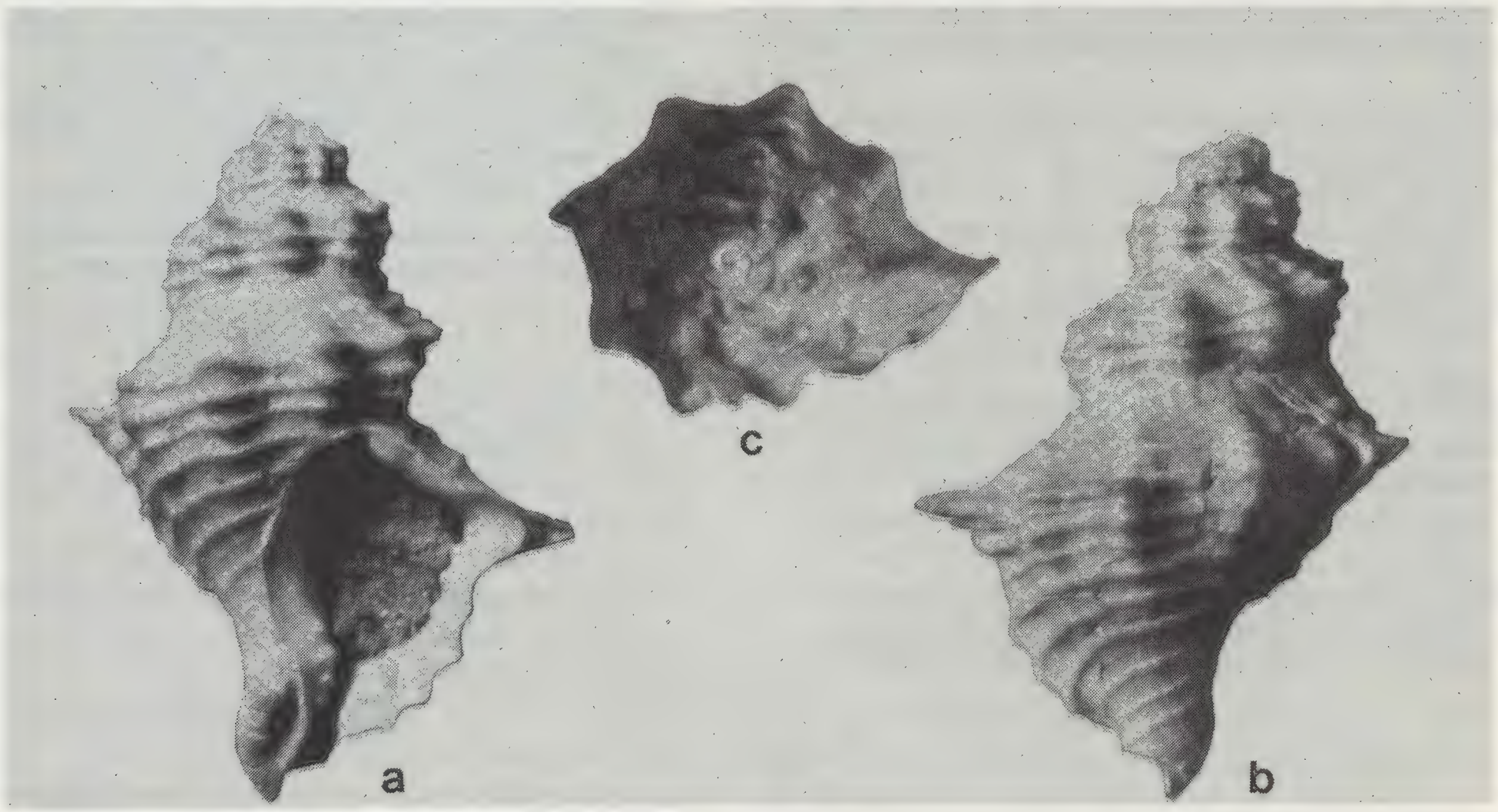

Text-figure 1. *Poirieria (? Panamurex) duoclavus* Garvie, n. sp. USNM 465512 (holotype); height 49.2 mm, diameter (including spines) 30.2 mm (X 1.2); Griffin sandpit, bed E, east of Chapelville, Lee County, Mississippi.

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December 9, 1992

FURTHER COMMENTS ON *HEXAPLEX FULVESCENS* (SOWERBY) AND *HEXAPLEX HERTWECKORUM* (PETUCH) (MOLLUSCA:GASTROPODA)

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In my original discussion (Vokes, 1968, p. 104) of *Hexaplex fulvescens* (Sowerby, 1834), I noted that the species "first appears in the upper Miocene Pinecrest Beds of southern Florida. It is never exceedingly abundant but it is well represented at several different Miocene localities in the vicinity of Lake Okeechobee." As we now know, the Pinecrest Beds (= Fruitville Formation of Waldrop and Wilson, 1990) are middle Pliocene and not "Miocene."

During the years of 1965 and 1966, at the localities along the Kissimmee River, north of Lake Okeechobee (TU localities 728, 729, 730, 769), we collected many muricid specimens, which I identified as being the same as the living *H. fulvescens*, but all were either juveniles or poorly preserved adults. Consequently, the two "Miocene" specimens I selected to figure in the 1968 work came from the beds along "Alligator Alley" (TU locality 797), where we also had collected numerous examples of what I took to be the same species.

Then, in 1969, at the now famous locality at Sarasota (TU 1000; originally the Warren Brothers pit, then McAsphalt, now APAC) large numbers of a species of *Hexaplex* began to be collected that was the same as those figured from "Alligator Alley" and obviously was *not* the same as *H. fulvescens*. Dazzled by the magnificent specimens from Sarasota, to my great embarassment I must confess I never once reexamined the miserable Kissimmee material.

In the first part of my summary and revision of the Cenozoic Muricidae (Vokes, 1990, p. 79), I acknowledged that the Pinecrest specimens I had originally assigned to *H. fulvescens* were actually *H. hertweckorum*, and added that true *H. fulvescens* had not been collected from beds earlier than the Late Pleistocene. No specimens to my knowledge had ever been collected from either the Caloosahatchee or Bermont formations, unless the locality TU 578 in St. Lucie County belonged in the latter formation.

In the most recent revision of the Cenozoic Muricidae (Vokes, 1992, p. 2) I stated that there must be post-Pliocene beds exposed somewhere at Sarasota because of the presence of the form that Petuch (1991, p. 26, pl. 4, figs. 3, 4) named *Muricanthus trippae*, but which I consider to be a synonym of *H. fulvescens*.

My attention was directed to the problem of the temporal distribution of *H. fulvescens* during a perusal of the paleontological collections at the Florida Museum of Natural History, Gainesville. There, from a locality on the Kissimmee River (UF HG001 = TU 770), were several specimens of what I would call *H. fulvescens*. This prompted my (belated) reexamination of our collections from the Kissimmee area and I realized that my original assessment was correct, there are specimens of true *H. fulvescens* in the Pliocene beds along the Kissimmee River.

The determination that *H. hertweckorum* is distinct from *H. fulvescens* has not changed. The only thing that has changed is the realization that both species occurred simultaneously in the Pliocene of southern Florida, rather than, as I erroneously concluded, *H. hertweckorum* being confined to the Pliocene beds and *H. fulvescens* confined to the post-Caloosahatchee beds.

Curiously, so far as I know, neither species has been taken in the Caloosahatchee Formation. In the Pinecrest Beds *H. hertweckorum* predominates in the vicinity of Sarasota, to as far south as "Alligator Alley." But in the more easterly beds, north of Lake Okeechobee, the main species is *H. fulvescens*. Neither species is absolutely confined to one area. In the Florida Museum collection there is one example of *H. hertweckorum* from the Kissimmee area and the species described as *H. trippae* (Petuch) indicates that rare specimens of *H. fulvescens* also occur in the Sarasota area.

In the Florida State Museum there are also many specimens of *H. fulvescens* from the Leisey Pit, near Ruskin, southwestern Hillsborough County. As Lyons (1991, p. 158) has discussed, the beds at the Leisey pit are unquestionably from the Bermont Formation (early Pleistocene).

Therefore, it is now obvious that *H. fulvescens* has been present in southern Florida since the Pliocene, and it was a contemporary of *H. hertweckorum*. Why the two species should have almost mutually exclusive ranges is not known. There must be some ecologic reason for the distribution, but what it is remains to be discovered.

Both species are assumed to have made their way to the American continent from the Old World. There is no American ancestor for either species. *Hexaplex fulvescens* [and its West Coast cognate *H. princeps* (Broderip, 1833)] is most closely related to the *H. rosarium* (Röding, 1798) complex that occurs in many forms (? species) along the western coast of Africa. It most especially resembles the form known as *Murex turbinatus* Lamarck, 1822 [not *M. turbinatus* Brocchi, 1814, = *H. canariensis* (Nordsieck, 1975); see Radwin and D'Attilio, 1976, p. 93, pl. 7, fig. 3, as *Phyllonotus trunculus*]. *Hexaplex hertweckorum*, as previously discussed (Vokes, 1988, p. 25) is most closely related to the living *H. duplex* (Röding, 1798) (see Radwin and D'Attilio, 1976, pl. 16, fig. 7), from the west coast of Africa.*

Therefore, my previous statements concerning *H. fulvescens* must be emended to note that the species first occurs in the Pliocene Pinecrest Beds (= Fruitville Formation) in the area to the north of Lake Okeechobee. Although there is a lack of specimens from the Caloosahatchee Formation, probably due to the carbonate nature of the unit (*H. fulvescens* prefers a clastic substrate), in the Bermont Formation of western Florida (and possibly eastern Florida at TU 578) the species reapppears and continues to be present in the same region until today.

In contrast *H. hertweckorum* is a true "waif," having come in to the Gulf of Mexico during the Early Pliocene, at the same time as it also made its way through the Bolivar Trough (Atrato Basin) to northwestern Ecuador (see Vokes, 1988, p. 24, pl. 1, fig. 8) and then quickly disappeared.

I wish to acknowledge my gratitude to Roger W. Portell, Florida State Museum of Natural History, Gainesville, and Albert Koller, Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, for the loan of specimens figured herein.

LOCALITY DATA

The following are Tulane University fossil locality numbers:

578. ?Bermont Formation. "Rim Ditch," spoil banks one-half mile south of Florida Highway 68 (Sec. 8, T35S, R38E), St. Lucie Co., Florida.
728. Pinecrest Beds [Fruitville Fm.], spoil banks on the west side of Kissimmee Canal and east side of Kissimmee River, just across from U.S. Corps of Engineers Structure 65-D (Sec. 33, T36S, R33E), Okeechobee Co., Florida.
729. Pinecrest Beds [Fruitville Fm.], spoil banks on west side of Kissimmee Canal and east side of Kissimmee River, approximately 1/2 mile south of U.S. Corps of Engineers Structure 65-D (S 1/2 Sec. 33, T36S, R33E), Okeechobee Co., Florida.
730. Pinecrest Beds [Fruitville Fm.], embankment of Seaboard Airline Railroad, just west of Kissimmee River (NW 1/4 Sec. 20, T36S, R33E) Highlands Co., Florida.
769. Pinecrest Beds [Fruitville Fm.], spoil banks on east side of Kissimmee River, 1 1/2 to two miles south of U.S. Corps of Engineers Structure 65-D (NE 1/4 Sec. 35, T36S, R33E), Okeechobee Co., Florida.
770. Pinecrest Beds [Fruitville Fm.] and Caloosahatchee Fm. mixed, spoil banks on west side of Kissimmee River, 1 1/2 to 3 1/2 miles north of Florida Highway 70 (Secs. 10, 14, 15, and 28, T37S, R33E), Highlands Co., Florida.
797. Pinecrest Beds [Fruitville Fm.], material exposed during construction of "Alligator Alley," 13.3 miles east of Florida Highway 29 (T49S, R32E), Collier Co., Florida.
1000. Pinecrest Beds [Fruitville Fm.], borrow pits at east end of 17th St. about 8 miles east of U.S. Highway 301 [now northwest of Fruitville Rd. exit on I-75], at Sarasota (T36S, R19E), Sarasota Co., Florida.

*In addition to these two species, the other members of American Pliocene to Recent *Hexaplex* also are derived from West Africa. The origins of the *H. radix-ambiguus-nigritus* complex on the west coast of tropical America seem to lie with the West African *H. angularis* (Lamarck, 1822) (see Radwin and D'Attilio, 1976, pl. 12, fig. 4), the only dark-colored form among the African species, all of which have a long fossil history in the Mio-Pliocene of the Mediterranean region. Presumably the peculiar West American *H. brassica* (Lamarck, 1822) (see Radwin and D'Attilio, 1976, pl. 16, fig. 5) is derived from the ancient line of *H. trunculus* (Linné, 1758), which also is well represented in the Mio-Pliocene of the Mediterranean Basin.

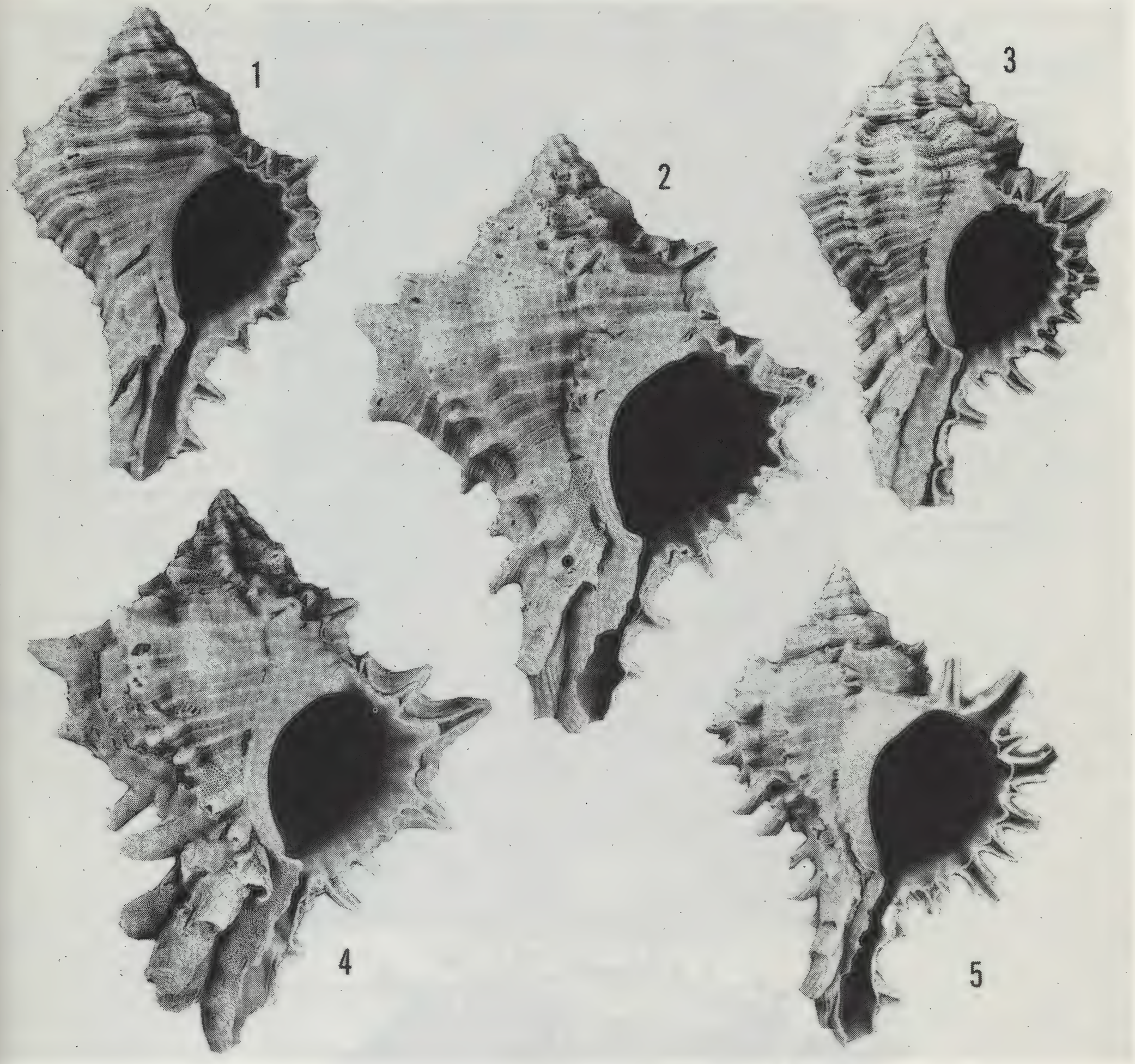

PLATE 1

Figures

1-4. *Hexaplex fulvescens* (Sowerby, 1834)

1. (X 1 1/4) UF 49178; height 46.8 mm, diameter 30.5 mm.
   Locality: Kissimmee River, Florida (= TU 770); Pinecrest Beds [Fruitville Formation].
2. (X 1) CM 35636 (holotype – *Muricanthus trippae* Petuch); height 67.6 mm, diameter 54.0 mm.
   Locality: APAC Pit, Sarasota, Florida (= TU 1000); Pinecrest Beds [Fruitville Formation].
3. (X 1 1/4) Vokes Collection; height 46.4 mm, diameter 30.5 mm.
   Locality: TU R-60, off Panama City, Florida, in 31 m; Recent.
4. (X 3/4) Vokes Collection; height 80.5 mm, diameter 67.8 mm.
   Locality: TU R-60, off Panama City, Florida, in 31 m; Recent.

5. *Hexaplex hertweckorum* (Petuch)
   (X 1) Vokes Collection; height 57.9 mm, diameter 43.2 mm.
   Locality: TU 1000, Sarasota, Florida; Pinecrest Beds [Fruitville Formation].

(Diameter of all specimens includes spines)

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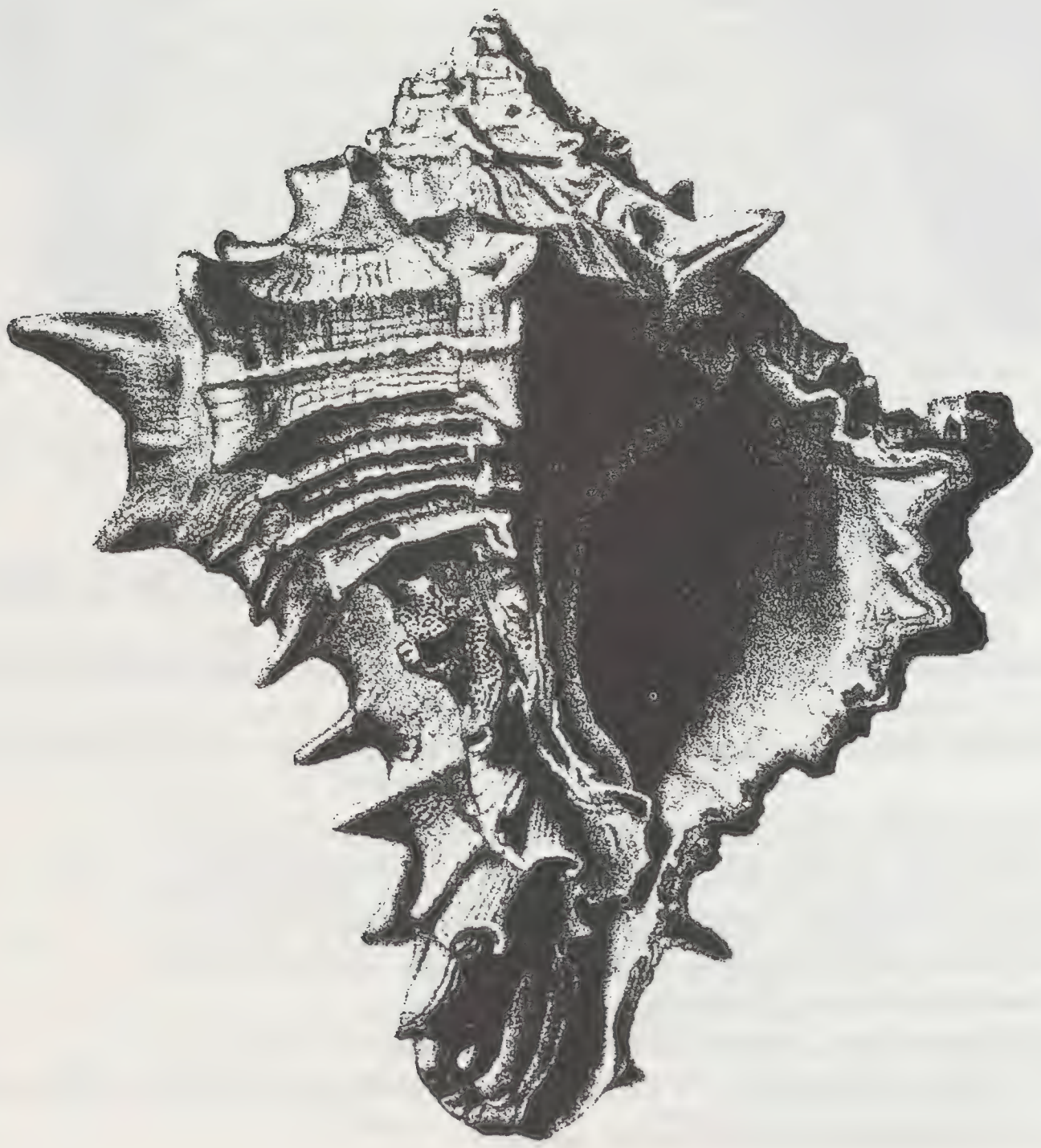

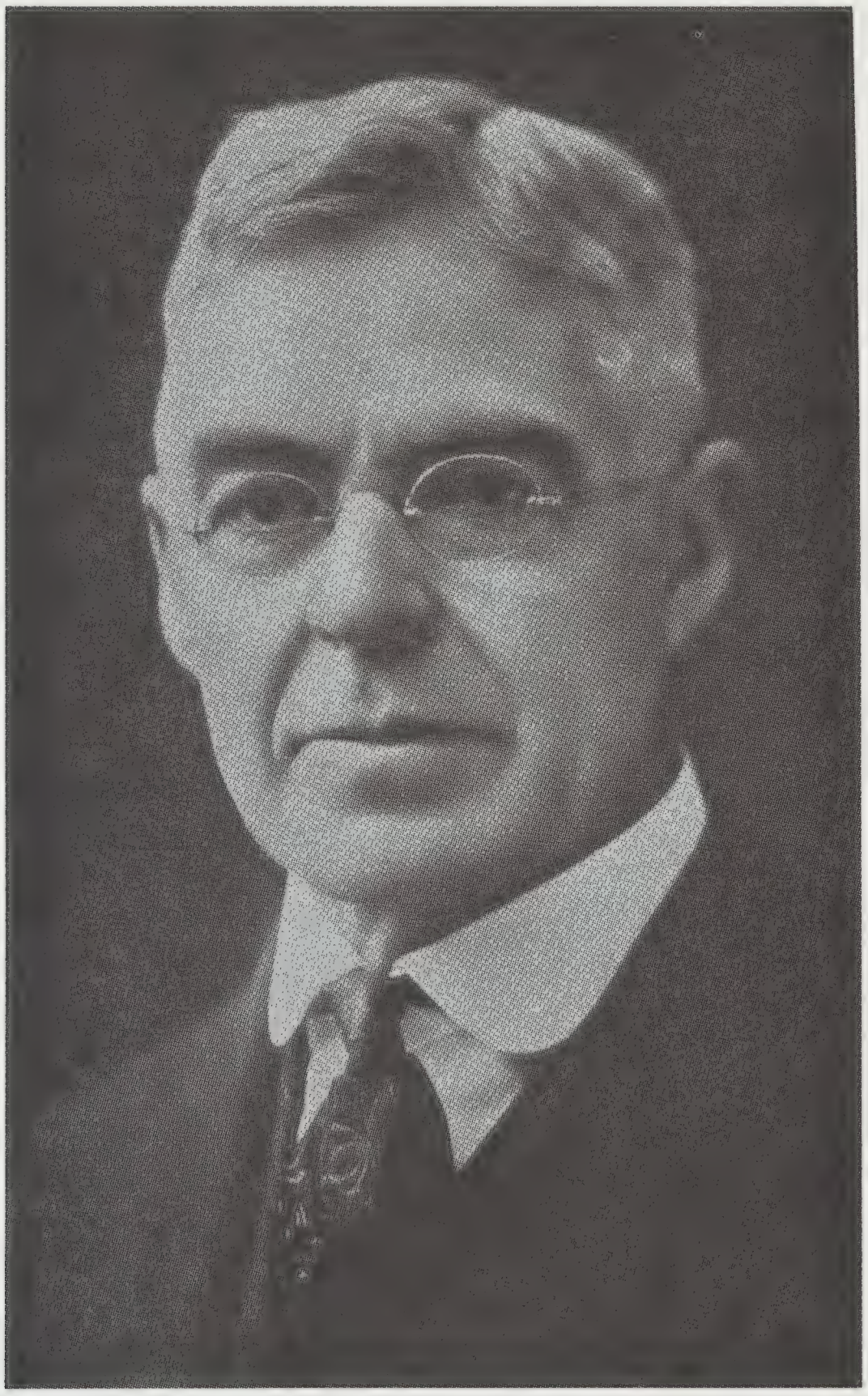

VIGNETTES IN COASTAL PLAIN GEOLOGY

GILBERT DENNISON HARRIS
(1864-1952)

G.D. Harris was born in Jamestown, New York, on a farm overlooking Chautauqua Lake amid the abundant Devonian fossils of the area. He graduated from Cornell University in 1887 and then joined in succession, the Arkansas Geological Survey, the Lousiana Geological Survey, the U.S. Geological Survey, and the Geological Survey of Texas. In 1894 he returned to Cornell University where he remained until his retirement in 1934. During his early work on the Tertiary beds of the Gulf Coastal Plain he realized the need for a rapid means of publishing paleontological papers, which resulted in his acquiring a small printing press from which he began issuing the *Bulletins of American Paleontology*, printing and binding it with his own hands. With retirement he founded the Paleontological Research Institution, dedicated to research in Paleontology and endowed liberally from his personal estate. Although he is best known for his numerous papers on the Eocene fossils of the Gulf Coast, he also published many papers on the geology of Louisiana salt domes, gas fields, and ground water. His most lasting contribution, however, was his legacy of students including Katherine V.W. Palmer, Axel A. Olsson, Kenneth E. Caster, and Arthur C. Veatch, among many others. (*From* A.A. Olsson, 1954, Proceedings Volume of the Geological Society of America, Annual Report for 1953)

VIGNETTES OF COASTAL PLAIN GEOLOGY

KATHERINE VAN WINKLE PALMER
(1895-1982)

A native of the state of Washington, Katherine V.W. Palmer became interested in Paleontology as an undergraduate at the University of Washington. Encouraged by her major Professor, Charles E. Weaver, she journeyed to Ithaca, New York, to Cornell University where she would study under Gilbert D. Harris. There she was to remain the rest of her life, becoming a founding member of the Paleontological Research Institution in 1935 and assuming its direction upon the death of Dr. Harris in 1952. She was the mainstay of the organization, serving as Director and Editor of the *Bulletins of American Paleontology* until her retirement in 1978. Upon the occasion of her retirement, Tulane University conferred upon her an honorary Doctor of Science degree, noting that she had authored over fifty scientific publications, principally on the paleontology of the Gulf Coastal Plain. (*See* Tulane Studies in Geology and Paleontology, v. 15)

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TULANE STUDIES IN GEOLOGY AND PALEONTOLOGY

Volume 26

1993-1994

HUBERT C. SKINNER

and

EMILY H. VOKES

Editors

TULANE UNIVERSITY OF LOUISIANA
New Orleans

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ULTRA-VIOLET LIGHT AS A USEFUL TOOL FOR IDENTIFYING FOSSIL MOLLUSKS, WITH EXAMPLES FROM THE GATUN FORMATION, PANAMA

WILLIAM D. PITT [1,2] and LOIS J. PITT [2]

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I. ABSTRACT

The color patterns of the 31 species illustrated here represent 30 species known from the Gatun Formation, and one that is new to the formation. These illustrations show the usefulness of ultra-violet light to distinguish morphologically similar forms, fossil and Recent.

II. INTRODUCTION

The use of ultra-violet light to induce fluorescense was pioneered by the late Axel Olsson of Coral Gables, Florida, in the 1960's; however, it was not widely used by him, or by many other workers, as a tool in the identification of fossil mollusks. This process has been more commonly used by Harold and Emily Vokes from Tulane University (Vokes and Vokes, 1968), and has also been used by Hoerle (1976), Pitt and Pitt (1992), as well as others.

The procedure used to induce fluorescense is to soak the specimens in a chlorine bleach for three days prior to photography. For the photographic process, Kodak Plus-X Pan film was used. We used a 6 watt, long-wave ultra-violet light. To counteract the effects of the light on the film, a yellow filter must be used. The photographs were taken at F/8 for two minutes. Exposure times from one minute to about two and one-half minutes seemed to make little difference in the results, although time must be increased if camera distance from the specimen is increased significantly. The photograph of *Turritella abrupta* (the largest specimen) was taken at three minutes. We used a single light, which was hand held for one minute on each side of the specimen. It was found that better results were obtained if the light was held above the plane of the camera lens. The photographs, as taken, show a reverse color pattern when printed, which is corrected by making a reverse negative. For a more complete account of the process see Krueger (1974).

The color patterns in the following species, for the most part, show a distinctive pattern for the species represented, but some seem to be highly variable. Most show patterns very similar to their living cognates.

The group that appears most in need of a major revision is the Cones. The *Conus molis* Brown and Pilsbry, 1911, and *C. bravoi* Spieker, 1922, complexes appear to be a particular problem, as we have numerous specimens tentatively identified as belonging to this group that have strikingly different color patterns. The color patterns would seem to indicate that there are more species of *Conus* in the Gatun Formation than indicated by Woodring (1970).

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This report is to show the color patterns of some fossil mollusks from the Gatun Formation of Panama, and to indicate their possible relationship to other species (fossil and Recent). It is not intended to be a taxonomic study of the species reported herein.

III. ACKNOWLEDGMENTS

We want to thank Emily Vokes of Tulane University for her encouragement of our endeavours and her help with this paper, Wayne Barnett of Houston, Texas for most of the ultra-violet photography, and Allan McMakin of Hammond, Oregon for the prints.

ABREVIATIONS FOR REPOSITORY INSTITUTIONS

ANSP - Academy of Natural Sciences, Philadelphia
BM(NH) - British Museum (Natural History)
CASG - California Academy of Sciences (Geology)
CASGTC - California Academy of Sciences (Geology Type Collections)
PRI - Paleontological Research Institution
USGS - United States Geological Survey
USNM - United States Museum of Natural History

IV. SYSTEMATIC PALEONTOLOGY

Class GASTROPODA
Order MESOGASTROPODA

ARCHITECTONICA (ARCHITECTONICA) NOBILIS Röding
Plate 1, figure 1

Architectonica nobilis RÖDING, 1798, Museum Boltenianum, p. 78.
Architectonica nobilis nobilis Röding. WOODRING, 1959, U.S. Geol. Survey, Prof. Paper 306-B, p. 165, pl. 29, figs. 1-6, 10-12, 14-16.

Holotype: Museum Boltenianum.
Type locality: Recent, unknown.
Occurrence: Gatun Formation, Panama. Esmeraldas beds, Ecuador. Recent, western Atlantic and eastern Pacific.

ARCHITECTONICA (ARCHITECTONICA) KARSTENI Rutsch
Plate 1, figure 2

Architectonica nobilis karsteni RUTSCH, 1934, Schweizer. Palaeont. Gesell., Abh., vol. 54, no. 3, p. 44, pl. 1, figs. 8-10.
Architectonica (Architectonica) nobilis karsteni Rutsch. WOODRING, 1959, U.S. Geol. Survey, Prof. Paper 306-B, p. 167, pl. 30, figs. 1-3.
Architectonica (Architectonica) karsteni (Rutsch). DeVRIES, 1985, Veliger, v. 27, no. 3, p. 282, figs. 2-12, 15, 16, 18, 20.

Holotype: Naturhistorisches Museum, Basel H-1836.
Type locality: Punta Gavilán Formation; Punta Gavilán, Venezuela.
Occurrence: Gatun Formation, Panama. Cantaure and Punta Gavilán formations, Venezuela. Esmeraldas beds and Duale Formation, Ecuador. Lobitos Tablazo, Peru. Navidad Formation, Chile. Agueguexquite Formation, Mexico. Recent, Mexico to Ecuador.

Discussion: DeVries (1985, p. 282) elevated the subspecies *Architectonica (A.) nobilis karsteni* Rutsch, 1934, to full species rank, based on morphological observations of specimens from numerous localities. DeVries also reported the first time occurrences of the species in the Recent Tropical East Pacific, from Baja California, Mexico to Cabo Pasado, Ecuador.

TURRITELLA (TURRITELLA) ABRUPTA Spieker
Plate 1, figure 3

Turritella robusta var. *abrupta* SPIEKER, 1922, Johns Hopkins Univ., Studies in Geology, no. 3, p. 85, pl. 4, fig. 6.
Turritella abrupta Spieker. WOODRING, 1957, U.S. Geol. Survey, Prof. Paper 306-A, p. 106, pl. 23, figs. 6, 15, 16.

Holotype: Johns Hopkins University.
Type locality: Zorritos Formation; Zorritos, Peru.
Occurrence: Gatun Formation, Panama. Zorritos Formation, Peru. Angostura and Progreso formations, Ecuador. Punta Gavilán Formation, Venezuela. Tubará Group, Colombia.

TURRITELLA (TORCULA) ALTILIRA ALTILIRA Conrad
Plate 1, figure 4

Turritella altilira CONRAD, 1857, Pacific Railroad Expl., v. 6, pt. 2, p. 72, pl. 5, fig. 19.
Turritella (Torcula) altilira altilira Conrad. WOODRING, 1957, U.S. Geol. Survey, Prof. Paper 306-A, p. 102, pl. 23, figs. 1, 7, 12, 13.

Lectotype: ANSP 3513.
Type locality: Gatun Formation; Panama.
Occurrence: Gatun Formation, Panama. Unknown formations, Colombia and Venezuela.

NATICA (NATICA?) BOLUS
Brown and Pilsbry
Plate 1, figure 5

Natica bolus BROWN and PILSBRY, 1913, Acad. Nat. Sci. Phila., Proc., v. 64, p. 508, pl. 22, fig. 9.
Natica (Natica?) bolus Brown and Pilsbry. WOODRING, 1957, U.S. Geol. Survey, Prof. Paper 306-A, p. 84, pl. 20, figs. 1-3.

Holotype: ANSP 3846.
Type locality: Gatun Formation; Canal Zone, Panama.
Occurrence: Gatun Formation, Panama. Cercado and Gurabo formations, Dominican Republic. Springvale Formation, Trinidad.

NATICA (STIGMAULAX) GUPPIANA
Toula
Plate 1, figure 6

Natica guppiana TOULA, 1909, Geol. Reichs., Jahrb., v. 58, p. 696, pl. 25, fig. 6.
Stigmaulax guppiana (Toula). WOODRING, 1957, U.S. Geol. Survey, Prof. Paper 306-A, p. 86, pl. 20, figs. 11-16.

Type: Tech. Hochschule, Vienna.
Type locality: Gatun Formation; Gatun Locks, Canal Zone, Panama.
Occurrence: Gatun Formation, Panama. La Vela Formation, Venezuela. Tubará Group, Colombia. Angostura Formation and Daule Group, Ecuador. Río Banano Formation, Costa Rica. Shoal River Formation, Florida.

CYPRAEA (MURACYPRAEA) HENEKENI
Sowerby
Plate 1, figure 7

Cypraea henikeri SOWERBY, 1850, Geol. Soc. London, Quart. Jour., v. 6, p. 45, pl. 9, fig. 3 (error for *henekeni*).
Cypraea (Muracypraea) henekeni Sowerby. WOODRING, 1959, U.S. Geol. Survey, Prof. Paper 306-B, p. 194, pl. 31, figs. 6-10; pl. 32, figs. 1, 4, 6, 9.

Lectotype: BM(NH) G 83940.
Type locality: Cercado or Gurabo Formation, Dominican Republic.
Occurrence: Gatun Formation, Panama. Cercado and Gurabo formations, Dominican Republic. Springvale and Brasso formations, Trinidad. Unknown formations, Venezuela and Colombia. Angostura Formation and Esmeraldas beds, Ecuador. Bowden Formation, Jamaica, Río Banano Formation, Costa Rica.

Order NEOGASTROPODA

HAUSTELLUM POLYNEMATICUS
(Brown and Pilsbry)
Plate 2, figure 1

Murex polynematicus BROWN and PILSBRY, 1911, Acad. Nat. Sci. Phila., Proc., v. 63, p. 353, pl. 26, fig. 1.
Murex (Murex) polynematicus Brown and Pilsbry. WOODRING, 1959, U.S. Geol. Survey, Prof. Paper 306-B, p. 215, pl. 36, figs. 2, 3; pl. 37, figs. 6, 9.
Haustellum polynematicus Brown and Pilsbry. VOKES, 1990, Tulane Stud. Geol. Paleont., v. 23, nos. 1-3, p. 13, pl. 1, fig. 11.

Holotype: ANSP 1719.
Type locality: Gatun Formation; Gatun Locks, Canal Zone, Panama.
Occurrence: Gatun Formation, Panama. Angostura Formation and Esmeraldas beds, Ecuador. (?)Angostura Formation, Nariño, Colombia.

POIRIERIA (PANAMUREX) GATUNENSIS
(Brown and Pilsbry)
Plate 2, figure 2

Murex (Phyllonotus) gatunensis BROWN and PILSBRY, 1911, Acad. Nat. Sci. Phila., Proc., v. 63, p. 354, pl. 26, fig. 2.
Paziella (Panamurex) gatunensis (Brown and Pilsbry). WOODRING, 1959, U.S. Geol. Survey, Prof. Paper 306-B, p. 217, pl. 35, figs. 6, 7, 9, 10.
Poirieria (Panamurex) gatunensis (Brown and Pilsbry). VOKES, 1992, Tulane Stud. Geol. Paleont., v. 25, nos. 1-3, p. 40, pl. 8, figs. 3-6.

Holotype: ANSP 1720.
Type locality: Gatun Formation; Gatun Locks, Canal Zone, Panama.
Occurrence: Gatun Formation, Panama. Cantaure and Punta Gavilán formations, Venezuela. Tubará Group, Colombia.

ANTILLIPHOS (ANTILLIPHOS) CANDEI GATUNENSIS Toula
Plate 2, figure 3

Phos gatunensis TOULA, 1909, Geol. Reichs., Jahrb., v. 58, p. 701, pl. 25, fig. 11; pl. 28, fig. 6.
Antilliphos (Antilliphos) candei gatunensis (Toula). WOODRING, 1964, U.S. Geol. Survey, Prof. Paper 306-C, p. 264, pl. 42, figs. 3, 4.

Holotype: Lost; Neotype USNM 643660 (see Woodring, 1964, p. 264).
Type locality: Gatun Formation; Gatun Locks, Canal Zone, Panama.
Occurrence: Gatun Formation, Panama. Unknown formations, Colombia and Costa Rica.

CYMATOPHOS VEATCHI VEATCHI
(Olsson)
Plate 2, figure 4

Phos veatchi OLSSON, 1922, Bulls. Amer. Pale-

ontology, v. 9, no. 39, p. 121(293), pl. 9(12), figs. 2, 3.

Cymatophos veatchi veatchi (Olsson). WOODRING, 1964, U.S. Geol. Survey, Prof. Paper 306-C, p. 260, pl. 41, figs. 5, 6, 8, 13.

Syntypes: PRI 21021, 21022.

Type locality: Río Banano Formation; Hill 1a, Río Banano, Costa Rica.

Occurrence: Gatun Formation, Panama. Río Banano Formation, Costa Rica. Unknown formation, Venezuela.

STROMBINA (STROMBINA?) cf. LISSA
Gardner
Plate 2, figure 5

Strombina lissa GARDNER, 1947, U.S. Geol. Survey, Prof. Paper 142-H, p. 514, pl. 52, figs. 14, 15.

Strombina (Strombina?) cf. *lissa* Gardner. WOODRING, 1964, U.S. Geol. Survey, Prof. Paper 306-C, p. 254.

Holotype: USNM 371869.

Type locality: USGS 3742, Shoal River Formation; Shell Bluff, Shoal River, Walton County, Florida.

Occurrence: Gatun Formation, Panama. Shoal River Formation, Florida.

STROMBINA (STROMBINA) LESSEPSIANA
Brown and Pilsbry
Plate 2, figure 6

Strombina lessepsiana BROWN and PILSBRY, 1911, Acad. Nat. Sci. Phila., Proc., v. 63, p. 352, pl. 25, figs. 11, 12; WOODRING, 1964, U.S. Geol. Survey, Prof. Paper 306-C, p. 252, pl. 40, figs. 22, 23, 30, 31.

Holotype: ANSP 1718.

Type locality: Gatun Formation: Gatun Locks, Canal Zone, Panama.

Occurrence: Gatun Formation, Panama. Río Banano Formation, Costa Rica.

TORQUIFER PITTORUM
Roth
Plate 2, figure 7

Xancidae?, *Xancus?*, WOODRING, 1973, U.S. Geol. Survey, Prof. Paper 306-E, p. 480, pl. 73, figs. 12, 13.

Torquifer pittorum ROTH, 1981, Tulane Stud. Geol. Paleont., v. 16, no. 4, p. 149, pl. 1, figs. 1-4, 6.

Holotype: CASGTC 60375.

Type locality: CAS 58335, Gatun Formation; north of Transisthmian Highway, about 1 km northwest of Sabanita, Republic of Panama (9° 21.25' N, 79° 48.75' W).

Occurrence: Gatun Formation, Panama.

OLIVA (OLIVA) GATUNENSIS
Toula
Plate 2, figure 8

Oliva gatunensis TOULA, 1909, Geol. Reichs., Jahrb., v. 58, p. 702, pl. 25, fig. 12.

Oliva (Oliva) gatunensis Toula. WOODRING, 1964, U.S. Geol. Survey, Prof. Paper 306-C, p. 276, pl. 45, figs. 12, 13, 16.

PLATE 1

Figures Page

1. *Architectonica nobilis* Röding, 1798 2
CASG 66589.02; height 13.2 mm, diameter 22.1 mm (X 4.0).
Locality: P-95, Panama.
2. *Architectonica karsteni* Rutsch, 1934 2
CASG 66589.03; height 18.8 mm, diameter 31.6 mm (X 3.1).
Locality: P-95, Panama.
3. *Turritella abrupta* Spieker, 1922 2
Pitt F-100; height 151.4 mm, diameter 39.8 mm (X 6.5).
Locality: P-94, Panama.
4. *Turritella (Torcula) altilira altilira* Conrad, 1857 2
CASG 66589.04; height 44.0 mm, diameter 11.9 mm (X 1.6).
Locality: P-95, Panama.
5. *Natica bolus* Brown and Pilsbry, 1913 3
CASG 66589.05; height 13.9 mm, diameter 13.0 mm (X 3.6).
Locality: P-95, Panama.
6. *Natica (Stigmaulax) guppiana* Toula, 1909 3
CASG 66589.01; height 25.1 mm, diameter 23.7 mm (X 2.0).
Locality: P-95, Panama.
7. *Cypraea (Muracypraea) henekeni* Sowerby, 1850 3
CASG 66589.06; height 37.3 mm, diameter 22.3 mm (X 1.3).
Locality: P-95, Panama.

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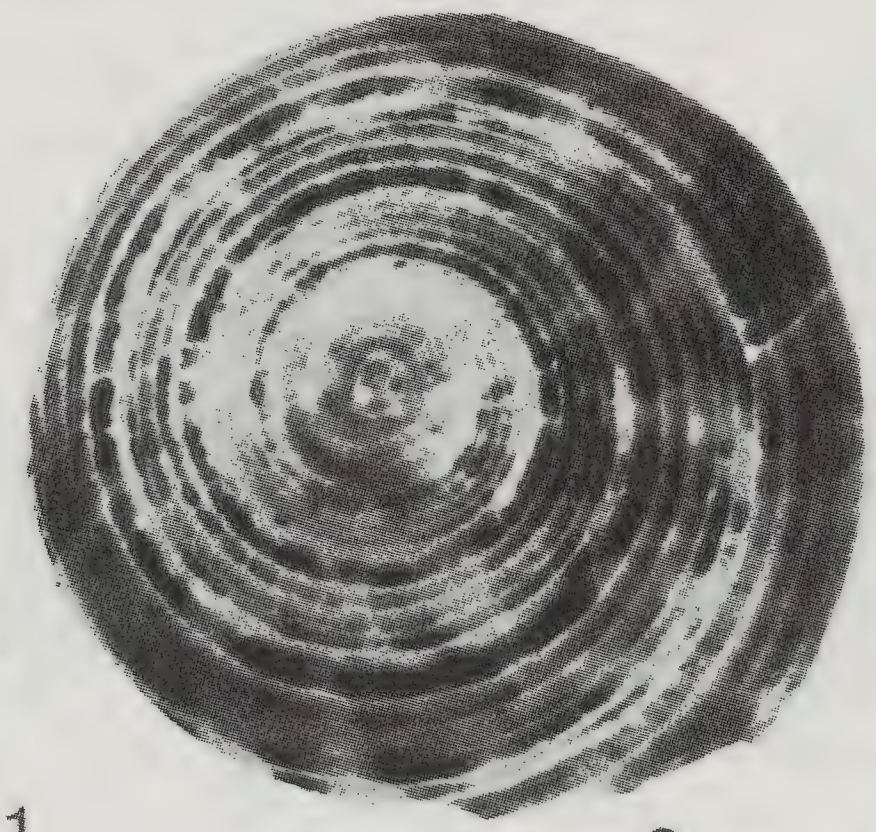
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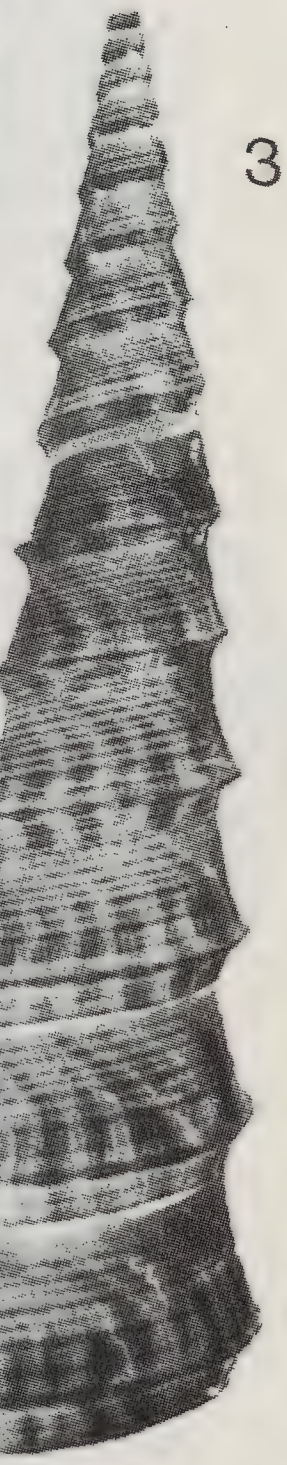
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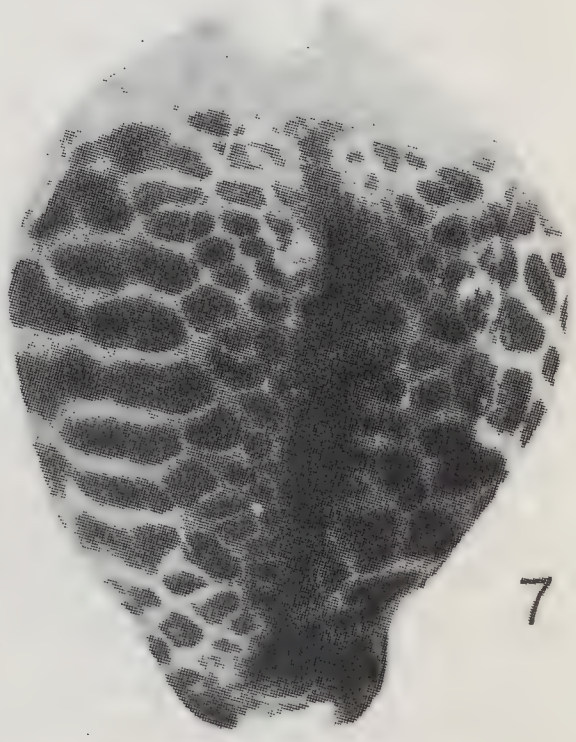
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PLATE 1

Lectotype: Tech. Hochschule, Vienna.
Type locality: Gatun Formation; Gatun Locks, Canal Zone, Panama.
Occurrence: Gatun Formation, Panama.

Oliva (Oliva) lisa
Perrilliat
Plate 2, figure 9

Oliva lisa PERRILLIAT, 1972, Paleontología Méxicana, no. 32, p. 103, pl. 49, fig. 9; pl. 50, figs. 1-7.

Holotype: USNM 349982.
Type locality: USGS 9995, Santa Rosa beds; 3 km northeast of Santa Rosa, Veracruz, Mexico.
Occurrence: Gatun Formation, Panama. Santa Rosa beds, Mexico.

Discussion: In comparing our specimens of *Oliva lisa* from the Gatun Formation to the holotype of *O. lisa* from Mexico we find no differences. *Oliva gatunensis* Toula is the Gatun Formation Olive most similar to *O. lisa* Perrilliat, however, it has a much higher spire. This is the first known report of *O. lisa* occurring in the Gatun Formation.

Cancellaria (Euclia) codazzii
Anderson
Plate 2, figure 10

Cancellaria codazzii ANDERSON, 1929, Calif. Acad. Sci., Proc., (ser. 4), v. 18, no. 4, p. 116, pl. 14, figs. 4-7.
Cancellaria (Euclia) codazzii Anderson. WOODRING, 1970, U.S. Geol. Survey, Prof. Paper 306-D, p. 339, pl. 54, figs. 3, 4, 7, 8, 11, 12.

Holotype: CAS 4645.
Type locality: Tubará Group; near Cibarco, Colombia.
Occurrence: Gatun Formation, Panama. Tubará Group, Colombia. Angostura Formation, Ecuador.

PLATE 2

Figures — Page

1. *Haustellum polynematicus* (Brown and Pilsbry, 1911) 3
USNM 450346; height 36.8 mm, diameter 23.4 mm (X 1.5).
Locality: TU 958, Panama.
2. *Poirieria (Panamurex) gatunensis* (Brown and Pilsbry, 1911) 3
USNM 462685; height 29.8 mm, diameter 18.0 mm (X 2.0).
Locality: TU 958, Panama.
3. *Antilliphos candei gatunensis* (Toula, 1909) 3
CASG 66589.07; height 22.5 mm, diameter 11.1 mm (X 2.2).
Locality: P-95, Panama.
4. *Cymatophos veatchi veatchi* (Olsson, 1922) 3
CASG 66694.01; height 26.0 mm, diameter 13.4 mm (X 3.7).
Locality: P-94, Panama.
5. *Strombina* cf. *lissa* Gardner, 1947 4
CASG 66695.01; height 10.3 mm, diameter 5.2 mm (X 4.9).
Locality: P-97, Panama.
6. *Strombina lessepsiana* Brown and Pilsbry, 1911 4
CASG 66589.08; height 24.1 mm, diameter 10.1 mm (X 2.1).
Locality: P-95, Panama.
7. *Torquifer pittorum* Roth, 1981 4
CASGTC 60375; height 82.8 mm, diameter 63.6 mm (X 0.85).
Type locality: CAS 58335, Panama.
8. *Oliva gatunensis* Toula, 1909 4
CASG 66694.02; height 35.1 mm, diameter 15.5 mm (X 1.4).
Locality: P-94, Panama.
9. *Oliva lisa* Perrilliat, 1972 6
CASG 66694.03; height 36.3 mm, diameter 16.5 mm (X 1.4).
Locality: P-94, Panama.
10. *Cancellaria (Euclia) codazzii* Anderson, 1929 6
CASG 66695.02; height 28.3 mm, diameter 19.4 mm (X 1.8).
Locality: P-97, Panama.

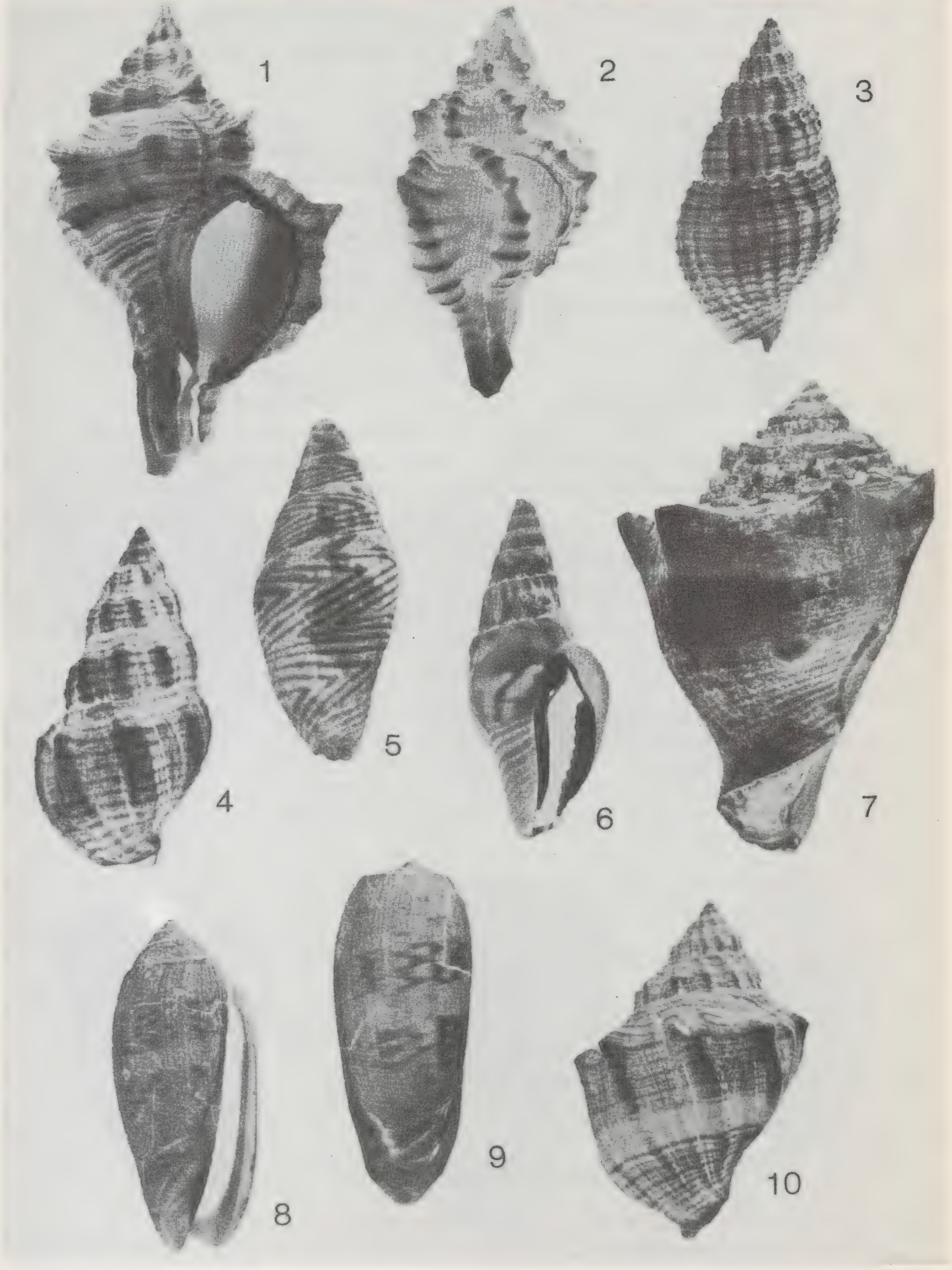


PLATE 2

CANCELLARIA (EUCLIA) DINOTA
Woodring
Plate 3, figure 1

Cancellaria (Euclia) dinota WOODRING, 1970, U.S. Geol. Survey, Prof. Paper 306-D, p. 340, pl. 54, figs. 1, 2; pl. 56, figs. 5, 6.

Holotype: USNM 645728.

Type locality: Woodring no. 138C, Gatun Formation; about 100 meters north side of Transistmian Highway and about 75 meters west of road to refinery site on Payardi Island, Panama; immediately east of Cativá and 100 meters north of locality 138.

Occurrence: Gatun Formation, Panama.

CONUS sp. #1
Plate 3, figure 2

Occurrence: Gatun Formation, Panama.

Discussion: This species compares favorably with *Conus bravoi* Spieker, 1922, except that the spire is slightly higher than most specimens of *C. bravoi*. The color pattern differentiates this from *C. bravoi* and other Gatun Cones. The color pattern most closely resembles that of the Recent eastern Pacific *Conus purpurascens* Sowerby, 1833, which differs from *C.* sp. in having spiral threads on the spire whorls and having a much wider aperture.

CONUS sp. #2
Plate 3, figure 3

Occurrence: Gatun Formation, Panama.

Discussion: This species is morphologically similar to the previous species, except that the spire is lower and the color pattern is completely different. It is possible that both of these species are undescribed.

CONUS sp. #3
Plate 3, figure 4

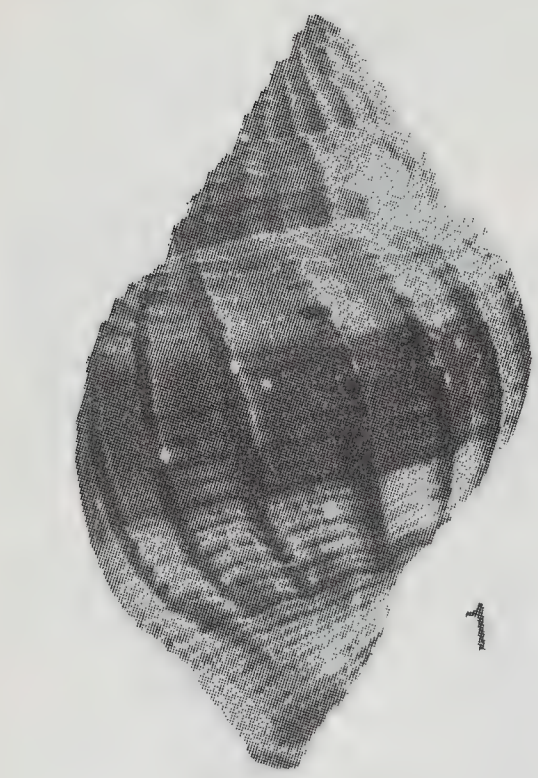
Occurrence: Gatun Formation, Panama.

Discussion: This species is morphologically similar to *Conus bravoi*. The color pattern is also similar but the central band is much more narrow and the axial bands are also more narrow. This may prove to be a variation within the species rather than a new species.

PLATE 3

Figures Page

1. *Cancellaria (Euclia) dinota* Woodring, 1970 8
CASG 66589.09; height 22.4 mm, diameter 13.4 mm (X 2.3).
Locality: P-95, Panama.
2. *Conus* sp. #1 8
CASG 66694.04; height 50.0 mm, diameter 29.5 mm (X 1.0).
Locality: P-94, Panama.
3. *Conus* sp. #2 8
CASG 66694.05; height 46.3 mm, diameter 27.0 mm (X 1.1).
Locality: P-94, Panama.
4. *Conus* sp. #3 8
CASG 66695.03; height 58.8 mm, diameter 35.9 mm (X 1.2).
Locality: P-97, Panama.
5. *Conus acolus* Woodring, 1970 10
CASG 66695.04; height 21.9 mm, diameter 13.2 mm (X 2.3).
Locality: P-97, Panama.
6. *Conus aemulator aemulator* Brown and Pilsbry, 1911 10
CASG 66695.05; height 48.9 mm, diameter 31.4 mm (X 1.0).
Locality: P-97, Panama.
7-8. *Conus bravoi* Spieker, 1922 10
7. CASG 66695.06; height 35.3 mm, diameter 21.3 mm (X 1.5).
Locality: P-97, Panama.
8. CASG 66695.07; height 47.0 mm, diameter 32.8 mm (X 1.2).
Locality: P-97, Panama.
9. *Conus burckhardti harrisi* Olsson, 1922 10
CASG 66695.08; height 25.0 mm, diameter 9.4 mm (X 2.2).
Locality: P-97, Panama.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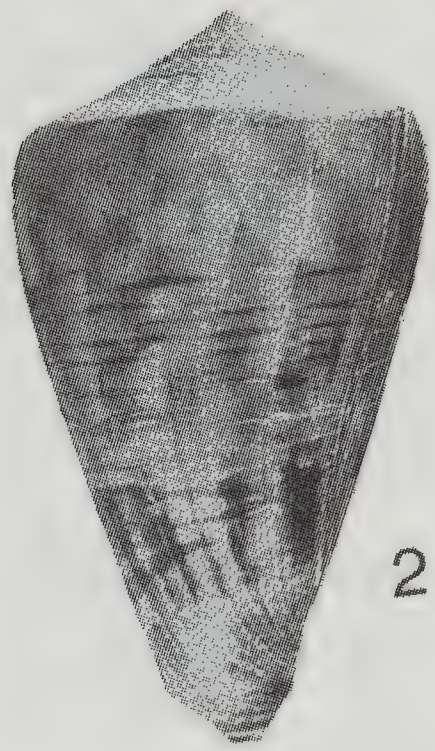
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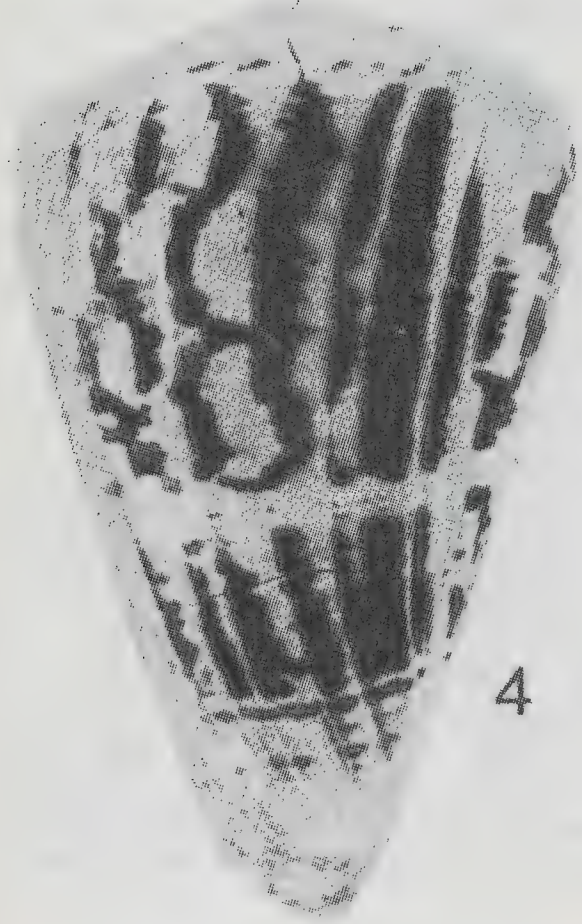
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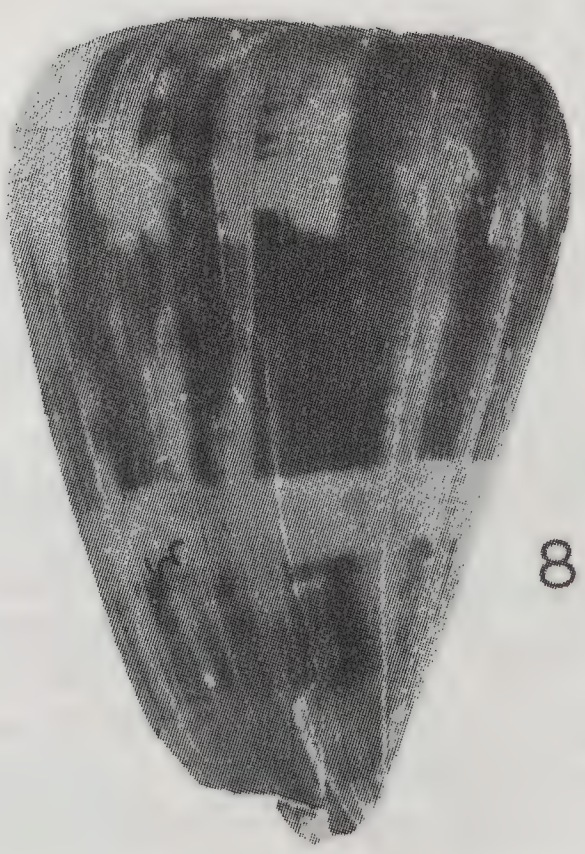
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PLATE 3

CONUS ACOLUS
Woodring
Plate 3, figure 5

Conus acolus WOODRING, 1970, U.S. Geol. Survey, Prof. Paper 306-D, p. 349, pl. 55, fig. 3.

Holotype: USNM 645741.
Type locality: Woodring no. 136A, (Stanford Univ. 2611) Gatun Formation; north side of Transisthmian Highway, 1.2 km northwest of Sabanita, Panama.
Occurrence: Gatun Formation, Panama. Angostura Formation, Ecuador.

Discussion: Conus acolus also occurs in the late Miocene Angostura Formation at Punta Verde, Esmeraldas Province, Ecuador, and has a close ally in the Recent Tropical East Pacific in *C. perplexus* Sowerby, 1857.

CONUS AEMULATOR AEMULATOR
Brown and Pilsbry
Plate 3, figure 6

Conus aemulator BROWN and PILSBRY, 1911, Acad. Nat. Sci. Phila., Proc., v. 63, p. 342, pl. 23, fig. 9.
Conus aemulator aemulator Brown and Pilsbry. WOODRING, 1970, U.S. Geol. Survey, Prof. Paper 306-D, p. 351, pl. 55, figs. 5, 6; pl. 56, figs. 4, 8.

Holotype: ANSP 1691.
Type locality: Gatun Formation; Gatun Locks, Canal Zone, Panama.
Occurrence: Gatun Formation, Panama. Cercado and Gurabo formations, Dominican Republic. Thomonde Formation, Haiti. Tubará Group, Colombia. Guayacan Formation? (see Whittaker, 1988, p. 16, fig. 5; p. 23), Ecuador.

CONUS BRAVOI
Spieker
Plate 3, figures 7, 8

Conus molis var. *bravoi* SPIEKER, 1922, Johns Hopkins Univ., Studies in Geol., no. 3, p. 41, pl. 1, fig. 6.
Conus bravoi Spieker. WOODRING, 1970, U.S. Geol. Survey, Prof. Paper 306-D p. 348, pl. 56, figs. 10, 11.

Holotype: Peabody Museum, Yale University.
Type locality: Zorritos Formation; Zorritos, Peru.
Occurrence: Gatun Formation, Panama. Zorritos Formation, Peru. Angostura and Progreso formations, Ecuador. Tubará Group, Colombia.

Discussion: Conus bravoi usually has a low evenly-tapering spire. The anal fasciole is flat or slightly concave, as noted by Woodring (1970, p. 348). The morphologic features noted by Woodring are variable and without the color pattern it would be difficult to separate many specimens of *C. bravoi* and *C. molis*.

CONUS BURCKHARDTI HARRISI
Olsson
Plate 3, figure 9

Conus harrisi OLSSON, 1922, Bulls. Amer. Paleontology, v. 9, no. 39, p. 53(225), pl. 3(6), fig. 1.
Conus burckhardti harrisi Olsson. WOODRING, 1970, U.S. Geol. Survey, Prof. Paper 306-D, p. 358, pl. 57, fig. 17.

Holotype: PRI 20899.
Type locality: Río Banano Formation; Hill 3, Río Banano, Costa Rica.
Occurrence: Gatun Formation, Panama. Punta Gavilán Formation, Venezuela. Guayacan Formation?, Ecuador. Río Banano Formation, Costa Rica.

CONUS CONSOBRINUS CONSOBRINUS
Sowerby
Plate 4, figure 1

Conus consobrinus SOWERBY, 1850, Geol. Soc. London, Quart. Jour., v. 6, p. 45.
Conus consobrinus consobrinus Sowerby. WOODRING, 1970, U.S. Geol. Survey, Prof. Paper 306-D, p. 352, pl. 56, figs. 3, 7, 9.

Lectotype: BM(NH) G83962.
Type locality: Dominican Republic.
Occurrence: Gatun Formation, Panama. Gurabo Formation, Dominican Republic. Agueguexquite Formation, Mexico. Bowden Formation, Jamaica.

CONUS cf. MOLIS
Brown and Pilsbry
Plate 4, figure 2

Conus molis BROWN and PILSBRY, 1911, Acad. Nat. Sci. Phila., Proc., v. 63, p. 343, pl. 23, fig. 1; WOODRING, 1970, U.S. Geol. Survey, Prof. Paper 306-D, p. 350, pl. 55, figs. 8-10.

Holotype: Princeton University, no. 5502.
Type locality: Gatun Formation; Gatun Locks, Canal Zone, Panama.
Occurrence: Gatun Formation, Panama. Tubará Group, Colombia. Río Banano Formation, Costa Rica.

Discussion: Woodring (1970, p. 350) noted that the anal fasciole is generally concave with spiral threads, although this is not a consistent feature. This immature specimen is one of many that we have with

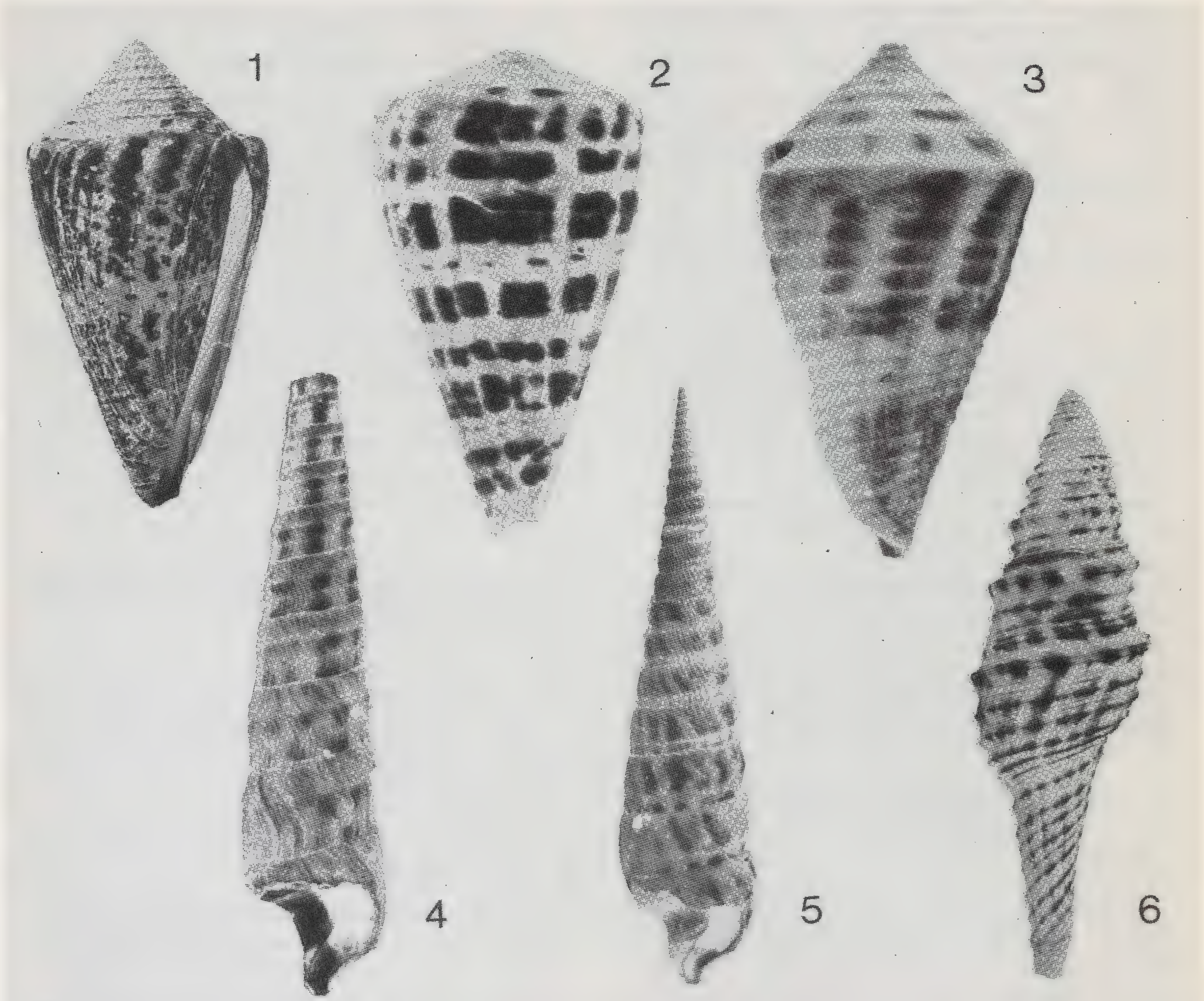

PLATE 4

Figures Page

1. *Conus consobrinus consobrinus* Sowerby, 1850 10
   CASG 66695.09; height 49.8 mm, diameter 25.5 mm (X 1.1).
   Locality: P-97, Panama.
2. *Conus* cf. *molis* Brown and Pilsbry, 1911 10
   CASG 66694.06; height 32.1 mm, diameter 19.8 mm (X 1.3).
   Locality: P-94, Panama.
3. *Conus multiliratus multiliratus* Böse, 1906 12
   CASG 66589.10; height 25.7 mm, diameter 14.7 mm (X 2.3).
   Locality: P-95, Panama.
4. *Terebra* species 12
   CASG 66696.01; height 76.9 mm, diameter 17.8 mm (X 1.0).
   Locality: P-98, Panama.
5. *Terebra (Panaterebra) cucurrupiensis* Oinomikado, 1939 12
   CASG 66589.11; height 76.1 mm, diameter 17.5 mm (X 0.9).
   Locality: P-95, Panama.
6. *Pleuroliria (Polystira) tenagos* (Gardner, 1938) 12
   CASG 66589.12; height 49.0 mm, diameter 15.1 mm (X 1.2).
   Locality: P-95, Panama.

a color pattern of spiral rows of crude rectangles, much like the color pattern of *C. spurius* Gmelin, as noted by Woodring (1970, p. 350). This specimen matches Woodring's description of *C. molis* closely except that it lacks the spiral threads on the anal fasciole.

Conus multiliratus multiliratus
Böse
Plate 4, figure 3

Conus agassizi multiliratus BÖSE, 1906, Inst. Geol. México, Bol. 22, p. 49, pl. 5, figs. 34-38.
Conus multiliratus multiliratus Böse. WOODRING, 1970, U.S. Geol. Survey, Prof. Paper 306-D, p. 356, pl. 57, figs. 3, 4.

Holotype: Inst. de Geología, Universidad Nacional de México (apparently lost).

Type locality: Tuxtepec, Oaxaca, Mexico.

Occurrence: Gatun Formation, Panama. Tubará Group, Colombia. Cercado and Gurabo formations, Dominican Republic. Unknown formation, Mexico. Río Banano Formation, Costa Rica. Bowden Formation, Jamaica. Daule Group and Esmeraldas beds, Ecuador.

Terebra species
Plate 4, figure 4

Occurrence: Gatun Formation, Panama.

Discussion: This species has affinities with *T. lucana* Dall, 1903; however, it differs in having the axials closer together, less pronounced and more curved. The shell is not as slender and lacks cross threads on the lower half of the body whorl. *Terebra lucana* lacks any color pattern and this species is possibly undescribed.

Terebra (Panaterebra) cucurrupiensis
Oinomikado
Plate 4, figure 5

Terebra (Paraterebra) cucurrupiensis OINOMIKADO, 1939, Geol. Soc. Japan, Jour., v. 46, p. 626, pl. 29, fig. 1.
Terebra (Panaterebra) cucurrupiensis Oinomikado. WOODRING, 1970, U.S. Geol. Survey, Prof. Paper 306-D, p. 407, pl. 61, figs. 10, 11, 15, 16.

Holotype: Geological Survey of Japan.

Type locality: Rio San Juan, Colombia.

Occurrence: Gatun Formation, Panama. Unknown formation, Colombia. Brasso Formation, Trinidad.

Pleuroliria (Polystira) tenagos
(Gardner)
Plate 4, figure 6

Polystira (Pleuroliria) tenagos GARDNER, 1938, U.S. Geol. Survey, Prof. Paper 142-F, p. 288, pl. 38, figs. 25, 26.
Pleuroliria (Polystira) tenagos (Gardner). WOODRING, 1970, U.S. Geol. Survey, Prof. Paper 306-D, p. 364, pl. 57, figs. 12, 23, 24; pl. 65, fig. 2.

Holotype: USNM 351134.

Type locality: USGS 3742, Shoal River Formation; Shell Bluff, Shoal River, Walton County, Florida.

Occurrence: Gatun Formation, Panama. Shoal River Formation, Florida.

V. LOCALITY DATA

The following is a United States Geological Survey locality:

USGS 9995. Head of small stream flowing into Arroyo Tomas Martinez, 3 km northeast of Santa Rosa [now Istal], or about 28 km west of Santa Lucrecia [now Jesus Carranza], on Veracruz-Pacific Railroad, Veracruz, Mexico. Coll. Bruce Wade, 1920.

The following is a California Academy of Sciences locality:

CAS 58335. North side of Transisthmian Highway, about 1 km northwest of Sabanita, Republic of Panama (9° 21.25' N, 79° 48.75' W).

The following is a Tulane University locality:

TU 958. Hillslope on east side of road from Boyd-Roosevelt Highway to "Refinería Panamá, S.A.," about 1/2 km north of junction, just east of Cativá, Prov. of Colón, Panama.

The following are Pitt localities and all are from the Gatun Formation, Colón Province, Panama:

P-94. Small hill on east side of road from Cativá to "Refinería Panamá S.A.," at Isla Payardi, about 3 km northeast of Cativá.
P-95. San Judas Todeo housing project, south side of Boyd-Roosevelt Highway, about 2 km west of Cativá.
P-97. North side of Boyd-Roosevelt Highway, about 1 km west of junction of road to Puerto Pilon at Sabanita.
P-98. Top of hill, directly north of junction of Boyd-Roosevelt Highway and road to Puerto Pilon at Sabanita.

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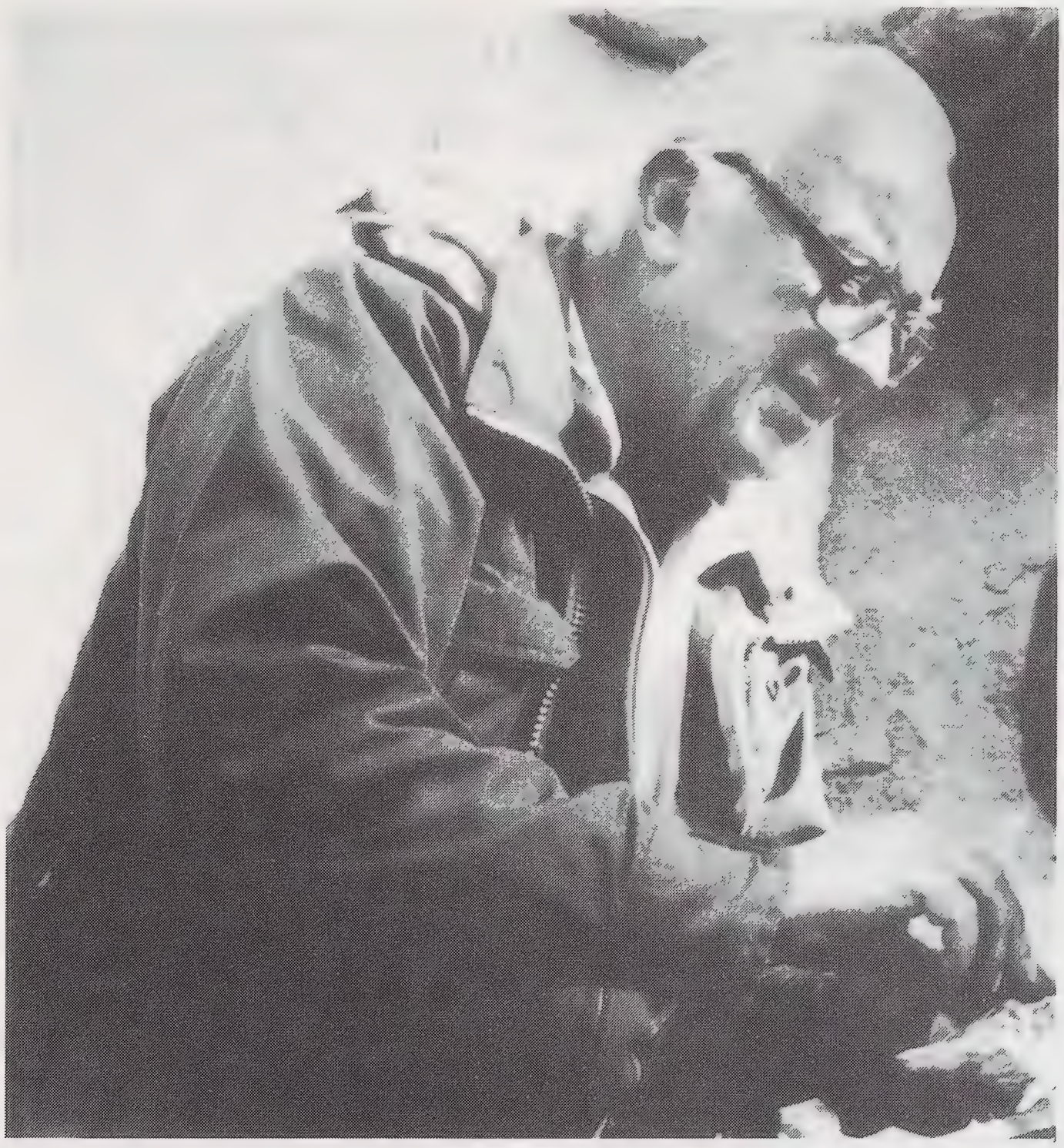

VIGNETTES OF COASTAL PLAIN GEOLOGY

NORMAN FREDERICK SOHL
(1924-1993)

Norm Sohl, the world's leading authority on Cretaceous stratigraphy and gastropods, began his long and distinguished career by collecting Silurian fossils from railroad rip-rap near his boyhood home is suburban Chicago. After an outstanding stint in the U.S. Army during World War II, when he received both a Purple Heart and a Bronze Star, he took advantage of the G.I. Bill to return to school. His original intention was to major in History but an elective course in Geology convinced him that Stratigraphy is the ultimate study of History. In 1954 he received his PhD and went to work for the U.S. Geological Survey the same year. Here Norm was to remain until his retirement, producing three monumental Professional Papers on the Upper Cretaceous of the Gulf Coastal Plain. He served in the largely thankless task of Branch Chief, Paleontology and Stratigraphy, for 14 years, receiving the two highest awards from the Department of Interior for his efforts. Through all of this he remained a dedicated field geologist, happiest when collecting the material that was the basis for his studies and unselfishly providing help and guidance to a generation of students and co-workers. (*From* John Pojeta, Jr., and G. Lynn Wingard, 1993. American Paleontologist, v. 1, no. 3)

EARLY EOCENE OSTREIDS FROM THE ADJUNTAS FORMATION, DIFUNTA GROUP, NORTHEASTERN MÉXICO

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I. ABSTRACT

Four ostreid species from the Lower Eocene Adjuntas Formation are reported, two of them described herein. The stratigraphic range and paleoenvironmental interpretation of the material reinforces previous conclusions on deltaic plain deposits of Lower Eocene age for the Adjuntas Formation.

II. INTRODUCTION

The Adjuntas Formation has proved to be the youngest and one of the most fossiliferous formations of the Difunta Group. Previous works have been devoted to the description of new molluscan taxa, found in the deltaic plain and inner shelf deposits of this formation (Vega and Perrilliat, 1989a; 1989b; 1992). The first formal stratigraphic report on the Difunta Group considered the Adjuntas Formation to be of Maastrichtian age, based on the presence of *Exogyra costata* Say (McBride *et al.*, 1974). Subsequently, Vega and Perrilliat (1989a) reported in the Adjuntas Formation the presence of *Venericardia (Venericor) planicosta* Lamarck and *Turritella mortoni postmortoni* Conrad, index fossils for the Ypresian of the Gulf Coastal Plain (Shimer and Shrock, 1944). Without detailed morphological examination, the ostreid species here reported superficially resemble *Exogyra costata*. It is probable that previous authors confused this Cretaceous grypheid with the Tertiary ostreids present in the Adjuntas Formation outcrops (McBride *et al.*, 1974; Wolleben, 1977).

The Adjuntas Formation has its most extensive outcrop areas in the synclines of the La Popa basin (Text-figure 1). The ostreids here described were collected at three localities in the Escondida and Delgado synclines (Text-figure 2).

III. STRATIGRAPHY AND PALEOENVIRONMENT

The ostreid subgenus *Turkostrea* has been reported in the Lower and Middle Eocene beds of the Mesogean region and the southern United States (Raulin and Delbos, 1855; Gardner, 1927; Vyalov, 1936, 1948). A wide distribution of ostreid taxa is proposed to be the result of island-hopping, when explaining interoceanic distributions (Stenzel, 1971). Ostreid beds of the Adjuntas Formation are included in a deltaic plain sequence, chiefly of red and green beds. The Adjuntas comprises mudstones, siltstones, and sandstones, with a thickness of 260 meters. Some gray beds at the base and the top of the formation include *Venericardia (Venericor) planicosta* and *Turritella mortoni postmortoni*, indicative of a Lower Eocene age. These gray beds have been interpreted as inner shelf deposits (Vega and Perrilliat, 1989b). The green beds of this formation contain a great abundance of freshwater gastropods, interpreted as inhabitants of deltaic plain deposits, below the phreatic level (Vega and Perrilliat, 1992).

The lithology of the Adjuntas Formation varies laterally and between the synclines where it outcrops. Lithology at localities IGM 1973 and IGM 2645 is more sandy than at the type section (McBride *et al.*, 1974), with almost no green beds, and the ostreids are distributed in well-defined strata of 1 to 2 meters thickness. Some sandstone beds between the ostreid banks contain tree-trunks in vertical position, replaced by light brown sandstone. Some red beds include leaf remains. The ostreid banks seem to be monospecific and the valves, although very near one to each other, rarely are found to be cemented. A coarse sandstone matrix of brown color includes all the ostreid remains. In other parts of the locality 2645, the left valves of the ostreids were found still attached to bored limestone fragments. This could represent an estuary, near the distributary channels, at whose edges the ostreid banks proliferated. A subsidence period in the La Popa basin generated conditions for the deposition of the Adjuntas Formation sediments, forming marshes, swamps, and estuaries, in which a diverse molluscan

fauna developed during Lower Eocene time.

IV. ACKNOWLEDGMENTS

We are grateful to M. en C. Zoila Graciela Castillo R. of the Instituto de Ciencias del Mar y Limnología, UNAM, for her kind help in comparison of the fossil material with collections of Recent ostreids at her laboratory. Mr. Luis Burgos P. cheerfully helped in doing the figures. Dr. E.H. Vokes (Tulane University) made valuable comments and critically reviewed the manuscript.

V. SYSTEMATIC DESCRIPTIONS

Order PTERIOIDA Newell, 1965

Suborder OSTREINA Ferussac, 1822
Superfamily OSTREACEA Rafinesque, 1815
Family OSTREIDAE Rafinesque, 1815

Genus OSTREA Linnaeus, 1758

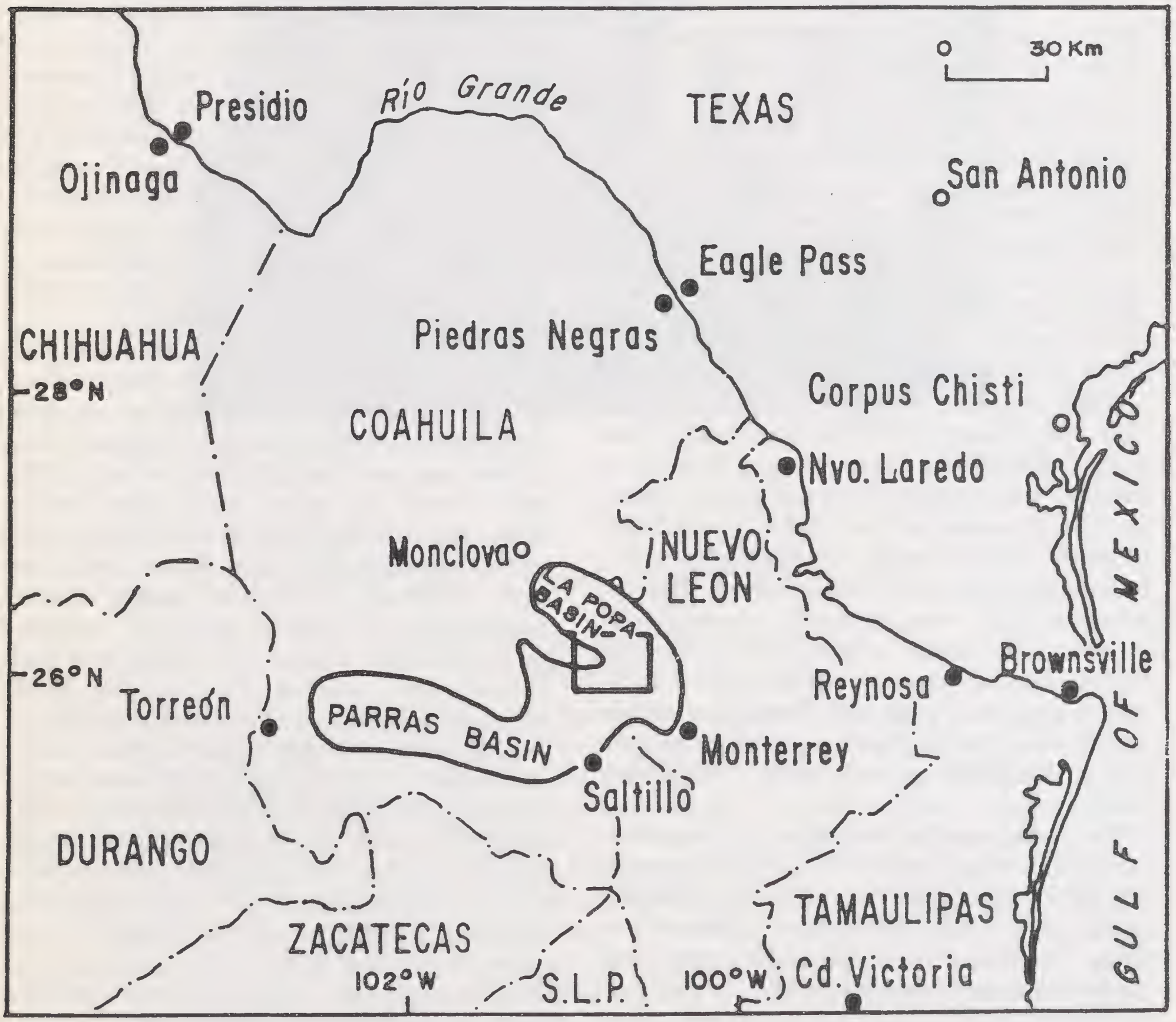
Ostrea Linnaeus, 1758, Systema naturae per tria regna naturae, p. 696.

Type species: *Ostrea edulis* Linnaeus; Recent, England; by subsequent designation, Children, 1823.

Subgenus TURKOSTREA Vyalov, 1936

Turkostrea Vyalov, 1936, Acad. Sci. USSR, Comptes Rendus (Doklady), new ser., v. 4 (13), no. 1, p. 18.

Type species: *Ostrea turkestanensis* Roma-



Text-figure 1. Generalized location map of Difunta Group in northeastern México, showing distribution of Parras and La Popa basins in Coahuila and Nuevo León states. Enclosed area in center is shown in text-figure 2.

novsky = *Ostrea strictiplicata* Raulin and Delbos; Central Asia (USSR, Uzbekistan); Montagne-Noire (Aude), France; Middle Eocene; by original designation.

OSTREA (TURKOSTREA) STRICTIPLICATA
Raulin and Delbos, 1855
Plate 1, figures 2, 5;
Plate 2, figures 2, 3

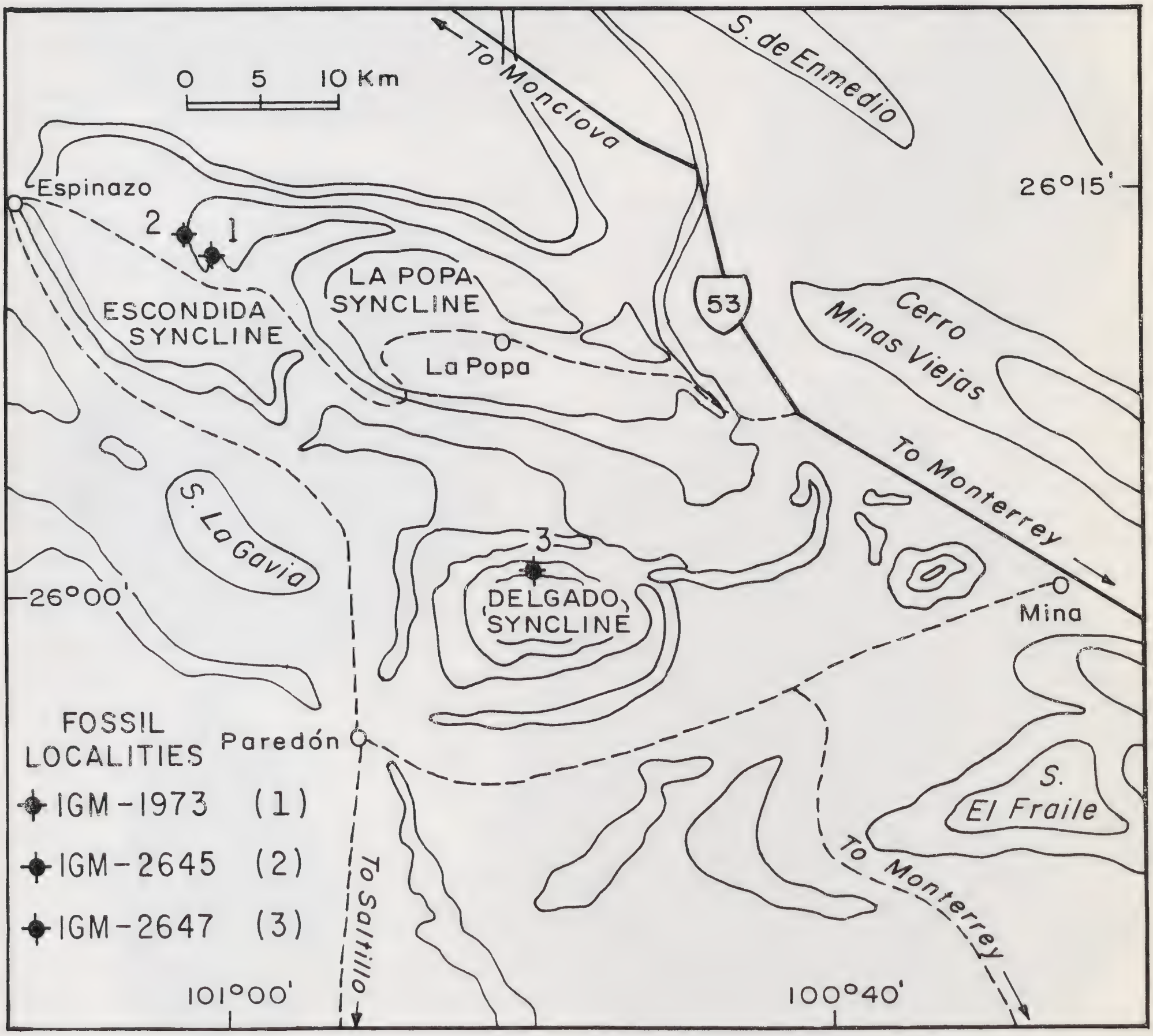
Ostrea strictiplicata RAULIN and DELBOS, 1855, Bull. Soc. Géol. France, sér. 2, v. 12, p. 1158.
Ostrea (Ostrea) moussoulensis ASTRE, 1922, Bull. Soc. Hist. Nat. Toulouse, v. 50, p. 161, pls. 1-6.
Ostrea multicostata Deshayes. KIEH, 1930, Bull. Soc. Géol. France, sér. 4, v. 30, p. 89.

"Test épais. Coquille arrondie-ovalaire. Valve gauche ornée d'environ 60 plis fins; surface d'adhérence petite; crochet, 1/6; canal assez profond, 1/2; bourrelets saillants; sillons profonds se continuant dans la valve par des points; expansions bien développées. Valve droite un peu convexe. Impression musculaire grande au centre de la moitié postérieure." (Raulin and Delbos, 1855)

Type locality: Terrain a Nummulites de la Montagne Noire (Aude), France.

Occurrence: Lutetian, Paris Basin; Lower Eocene, between Moussolens and Montolieu (Aude); Lutetian, Egypt, Transylvania Basin, Perse and Turkestan.

Figured specimens: Plate 1, figs. 2, 5, IGM 6312; length 24.9 mm, height 38.4 mm, diameter (both valves) 22.8 mm. Plate 2, figs. 2, 3, IGM 6311; length 75.4 mm, height 91.2 mm, diameter (both valves) 60.7 mm; locality IGM 1973.



Text-figure 2. Location map of the three ostreid localities in the Escondida and Delgado synclines, La Popa basin, Nuevo León, México.

Other occurrences: IGM locality nos. 1973, 2647.

Discussion: The complete synonymy of this species is in Kieh (1930, p. 89), who made a revision of the subspecies and varieties that have been assigned to this species, and which need not to be repeated here. Within the Mexican specimens from locality IGM 1973, we have smaller specimens than those called by Kieh as exogyroidals. We also have the gryphaeiform type; the Asiatic specimens show this feature also, while those from the meridional region of France and northern Africa have this feature only partially. Kieh (1930, p. 87) mentioned that this species lived in littoral zones or shores during the Middle Eocene, having numerous varieties, following various living conditions.

OSTREA (TURKOSTREA) DUVALI
Gardner, 1927
Plate 1, figures 1, 6;
Plate 2, figures 1, 6

Ostrea duvali GARDNER, 1927, Jour. Washington Acad. Sci., v. 17, no. 14, p. 366, figs. 1-4.

"Shell of moderate dimensions for the genus, inequivalve, ovate-trigonal in outline, frequently with a large attachment area and relatively broad in consequence. Surface layer decorticated; right valve built up of overlapping concentric lamellae so that the shell thins toward the ventral margin, and would be heaviest in the umbonal area were it not for the encroachment of the ligament area; a subcutaneous radial threading on the right valve but no true radial sculpture developed; left valve fluted with narrow radials ranging in number from 20 to 25 in the narrower forms, and running to 35 and 40 in the broader; obsolete on the attached surface. Ligament area large, flattened in the right valve; the medial depression in the left valve broadly U-shaped. Lateral margins of right valve finely pitted, the pitting persistent in some individuals around the entire inner margin. Adductor scars rather small, crescentic, not deeply excavated, posterior and below the median horizontal." (Gardner, 1927)

Description: Shell of large size, inequivalve and inequilateral, ovate-trigonal. The left valve has 20 to 25 radial ribs, some of them bifurcated in the ventral region. In the attachment area the surface of the shell is smooth. The ligament area is broad, the catachomata are present in almost all the margin of the shell. The adductor muscle is reniform. The right valve has an ornamentation of concentric lamellae. The anachomata are present all around the margin of the shell. The adductor muscle is big and deep. The Quenstedt muscle is present.

Type material: USNM 369239. Right valve; altitude 10.6 mm, latitude 6.1 mm, semi-diameter 2.4 mm. Left valve of another individual; altitude 10.5 mm, latitude 6.95 mm, semi-diameter 3.45 mm.

Type locality: Austin-Elgin Ferry road, 1 mile north of Austin-Bastrop Highway, Bastrop County, Texas.

Occurrence: Wilcox Group, probably the Indio Formation, Eocene.

Figured specimens: Plate 1, figs. 1, 6, IGM 6314; length 80.1 mm, height 78.3 mm, diameter (left valve) 34.0 mm. Plate 2, figs. 1, 6, IGM 6315; length 78.4 mm, height 93.7 mm, diameter (right valve) 24.6 mm; locality IGM 2645.

Discussion: The Mexican specimens are broader than the one described and figured from Texas, possibly due to the polymorphism of the oysters. We also have to consider the temperature of the water where they grew. In many of the valves the sculpture is worn, which may have been caused by the currents where they lived. We have only one small specimen that presents the same shape as the one figured by Gardner (1927, p. 366, figs. 1-4).

PLATE 1

Figures

1, 6. *Ostrea (Turkostrea) duvali* Gardner, 1927 (x 1).
IGM 6314; length 80.1 mm, height 78.3 mm, diameter (left valve) 34.0 mm.
Locality: IGM 2645, Adjuntas Formation, Nuevo León, México.

2, 5. *Ostrea (Turkostrea) strictiplicata* Raulin and Delbos, 1855 (x 1).
IGM 6312; length 24.9 mm; height 38.4 mm, diameter (both valves) 22.8 mm.
Locality: IGM 1973, Adjuntas Formation, Nuevo León, México.

3, 4. *Ostrea (Turkostrea) escondida* Perrilliat and Vega, n. sp. (x 1).
IGM 6317 (holotype); length 48.9 mm, height 56.9 mm, diameter (both valves) 36.0 mm.
Locality: IGM 2645, Adjuntas Formation, Nuevo León, México.

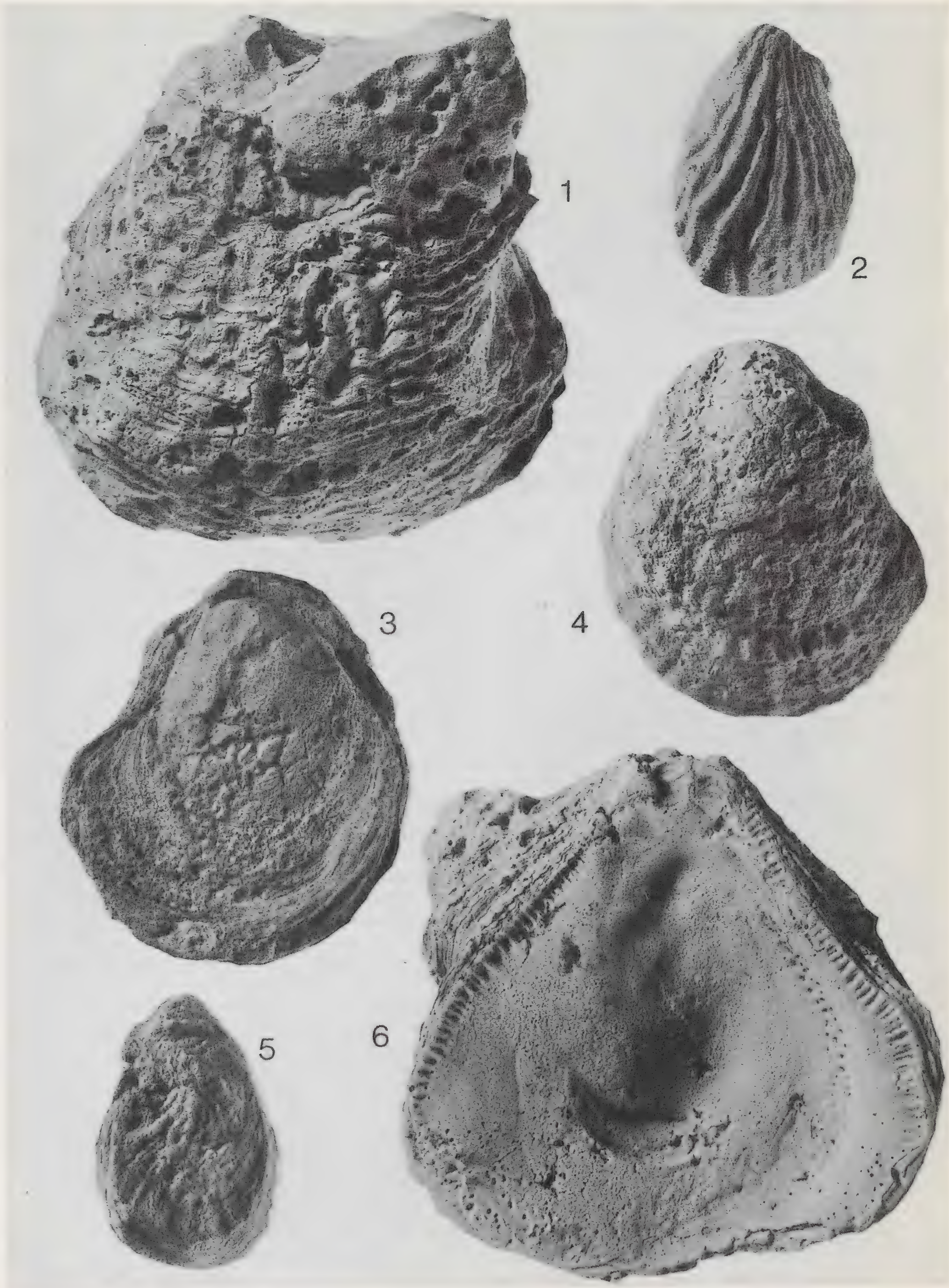


PLATE 1

OSTREA (TURKOSTREA) ESCONDIDA
Perrilliat and Vega, n. sp.
Plate 1, figures 3, 4;
Plate 2, figures 4, 5;
Plate 4, figures 1, 2, 4, 6

Description: Shell small for the genus, inequivalve and inequilateral. The left valve is convex, ovate-trigonal in outline. The sculpture is of numerous, thin radial ribs, some of them bifurcated in the ventral region. The umbo is opisthogyrous and the ligament area is narrow and trigonal, the catachomata are visible. The adductor muscle scar is reniform. The right valve has the same outline as the left one, the sculpture is of numerous, low concentric lamellae on the whole surface of the shell. Each lamella presents slender radial threads with narrow interspaces. The umbo is opisthogyrous and the ligament area is narrow. The anachomata are clear and the adductor muscle scar is reniform.

Holotype: IGM 6317, length 48.9 mm, height 56.9 mm, diameter 36.0 mm.

Paratype: IGM 6318, length 36.6 mm, height 42.7 mm, diameter 13.0 mm.

Type locality: IGM 2645. Southwest margin of the La Escondida syncline, approximately 20 km northwest of the town of San José de la Popa, and 15 km southeast of Espinazo village, Nuevo León, México.

Occurrence: Adjuntas Formation, México; Lower Eocene.

Etymology: The name of the species is dedicated to the Escondida syncline, where outcrops of Tertiary rocks have yielded a diverse macroinvertebrate fauna, with a great number of oyster banks.

Discussion: The Mexican specimens are not like any other species described from the Eocene. The most similar species is *Ostrea kochae* Gardner (1933, p. 140, pl. 8, figs. 1-5) from the Tehuacana Member, Kincaid Formation (Paleocene), from 7 1/2 miles southeast of D'Hanis, Medina County, Texas, but this species has overlapping lamellae in both valves, being more foliaceous in the left valve. The submargins are strongly punctate in the left valve and weak in the right valve.

Ostrea cynthiae Maury (1912, p. 37, pl. 6, fig. 5) from the Midway (Eocene) of Soldado Rock, Gulf of Paria, has a very convex left valve, not plicated, with irregular concentric lamellae, and the right valve has no sculpture. The main feature of the right valve of the Nuevo León specimens is the numerous, low concentric imbrications, each one of these with thin radial threads with narrow interspaces.

OSTREA (Subgenus?) POPAENSIS
Perrilliat and Vega, n. sp.
Plate 3, figures 1-6;
Plate 4, figures 3, 5

Description: Shell of medium size, trigonal, sometimes the posterior margin is elongated, inequilateral, inequivalve and thick. The right valve has an ornamentation of numerous radial ribs, bifurcated in the ventral margin, and covered by concentric lamellae. In some valves the ribs have disappeared and only thick concentric lamellae are present. The umbo is prosogyrous. The anachomata and/or relict anachomata are present. In a few specimens the Quenstedt muscle scar is preserved. The adductor muscle is in the posterior region, reniform and big. In a few specimens the mantle muscle scars are present. The margin is smooth. The left valve is concave and the attachment area is small. It has the same sculpture as the right valve, but the ribs are less pronounced. The interior of the valve is smooth and presents the Quenstedt muscle scar, mantle muscle scars, and the reniform adductor muscle. The umbo is prosogyrous. The catachomata are present in almost three-quarters of the margin.

Holotype: IGM 6321; length 70.7 mm, height 76.2 mm, diameter 30.0 mm.

Paratype: IGM 6322; length 57.3 mm, height

PLATE 2

Figures

1, 6. *Ostrea (Turkostrea) duvali* Gardner 1927 (x 1).
IGM 6315; length 78.4 mm, height 93.7 mm, diameter (right valve) 24.6 mm.
Locality: IGM 2645, Adjuntas Formation, Nuevo León, México.

2, 3. *Ostrea (Turkostrea) strictiplicata* Raulin and Delbos, 1855 (x 0.5).
IGM 6311; length 75.4 mm, height 91.2 mm, diameter (both valves) 60.7 mm.
Locality: IGM 1973, Adjuntas Formation, Nuevo León, México.

4, 5. *Ostrea (Turkostrea) escondida* Perrilliat and Vega, n. sp. (x 1).
IGM 6318 (paratype); length 36.6 mm; height 42.7 mm, diameter (right valve) 13.0 mm.
Locality: IGM 2645, Adjuntas Formation, Nuevo León, México.

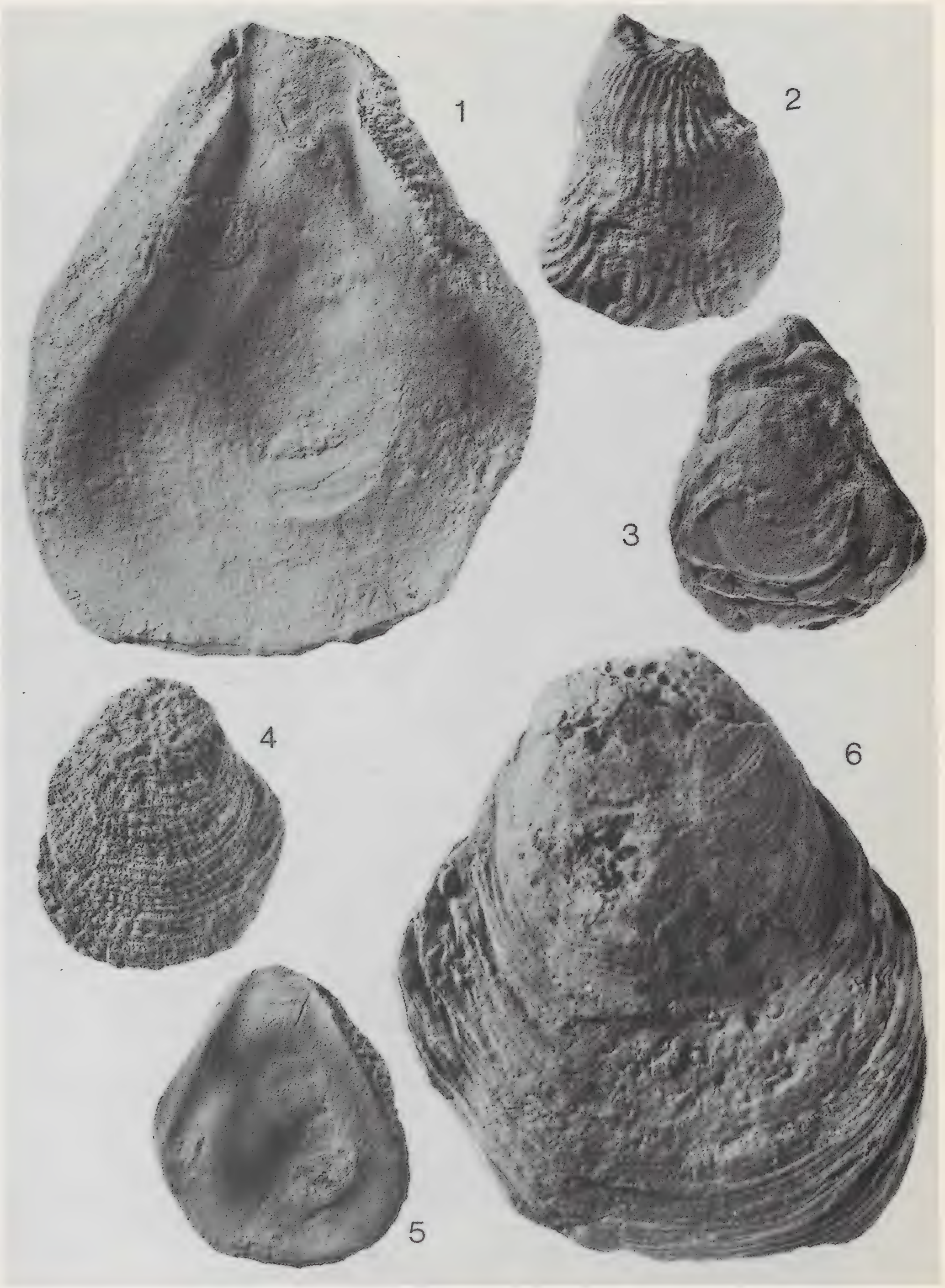


PLATE 2

67.0 mm, diameter 18.0 mm.

Type locality: IGM 2645. Southwest margin of the La Escondida syncline, approximately 20 km northwest of town of San José de La Popa, and 15 km southeast of Espinazo village, Nuevo León, México.

Occurrence: Adjuntas Formation, México; Lower Eocene.

Etymology: The name of the species is dedicated to the La Popa basin, the youngest and most fossiliferous area in the Difunta Group.

Discussion: Specimens of this new species are assigned to the genus *Ostrea*, but they cannot be assigned to any subgenus already described. In *Turkostrea* the right valve is smooth with concentric lamellae. In *Cubitostrea* the right valve is smooth and smaller than the left valve, but the trigonal shape is the same as in the Mexican specimens. In *Platygena* the outline is roughly orbicular; old shells are higher than long; outline of valve cavity in left valve banjo-shaped; no chomata, and its geological range is only Late Eocene.

Sokolowia is highly inequivalve, left valve umbonal region extending beyond right cavity; chomata well developed; valve cavity guitar-shaped in outline; right valve devoid of ribs, but with prominent growth squamae; many have auricles.

No similar species are known from the Eocene. The only species that can be compared to its triangular shape is *Ostrea villei* Coquand (1862, pl. 22, figs. 1-4; 1869, p. 27, pl. 5, figs. 1, 2) from the Maastrichtian of Djilail, Algeria, but the latter has the same sculpture in both valves, and at present is included in the genus *Ambigostrea* Malchus, 1990.

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PLATE 3

Figures

1, 4. *Ostrea* (Subgenus?) *popaensis* Perrilliat and Vega, n. sp. (x 1).
IGM 6321 (holotype); length 70.7 mm, height 76.2 mm, diameter (right valve) 30.0 mm.
Locality: IGM 2645, Adjuntas Formation, Nuevo León, México.

2, 3. *Ostrea* (Subgenus?) *popaensis* Perrilliat and Vega, n. sp. (x 1).
IGM 6323 (paratype); length 41.1 mm, height 46.0 mm, diameter (left valve) 18.2 mm.
Locality: IGM 2645, Adjuntas Formation, Nuevo León, México.

5, 6. *Ostrea* (Subgenus?) *popaensis* Perrilliat and Vega, n. sp. (x 1).
IGM 6322 (paratype); length 57.3 mm, height 67.0 mm, diameter (right valve) 18.0 mm.
Locality: IGM 2645, Adjuntas Formation, Nuevo León, México.

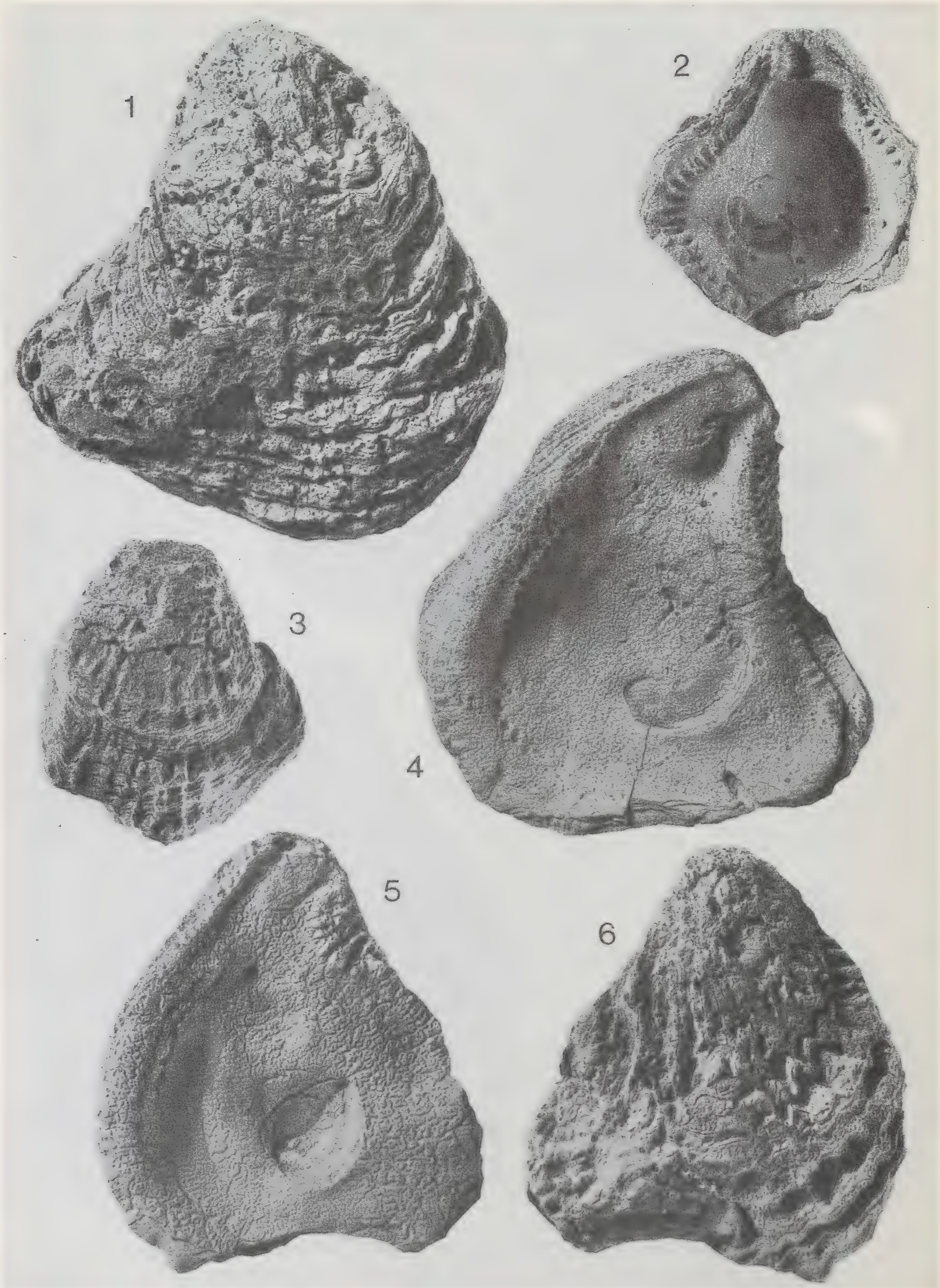

PLATE 3

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December 29, 1993

PLATE 4

Figures

1, 2. *Ostrea (Turkostrea) escondida* Perrilliat and Vega, n. sp. (x1).
IGM 6319 (paratype); length 44.4 mm, height 49.7 mm, diameter (right valve) 16.5 mm.
Locality: IGM 2645, Adjuntas Formation, Nuevo León, México.

3, 5. *Ostrea* (Subgenus?) *popaensis* Perrilliat and Vega, n. sp. (x 1).
IGM 6324 (paratype); length 73.3 mm, height 90.2 mm, diameter (right valve) 23.3 mm.
Locality: IGM 2645, Adjuntas Formation, Nuevo León, México.

4, 6. *Ostrea (Turkostrea) escondida* Perrilliat and Vega, n. sp. (x 1).
IGM 6320 (paratype); length 48.6 mm, height 58.0 mm, diameter (left valve) 16.2 mm.
Locality: IGM 2645, Adjuntas Formation, Nuevo León, México.

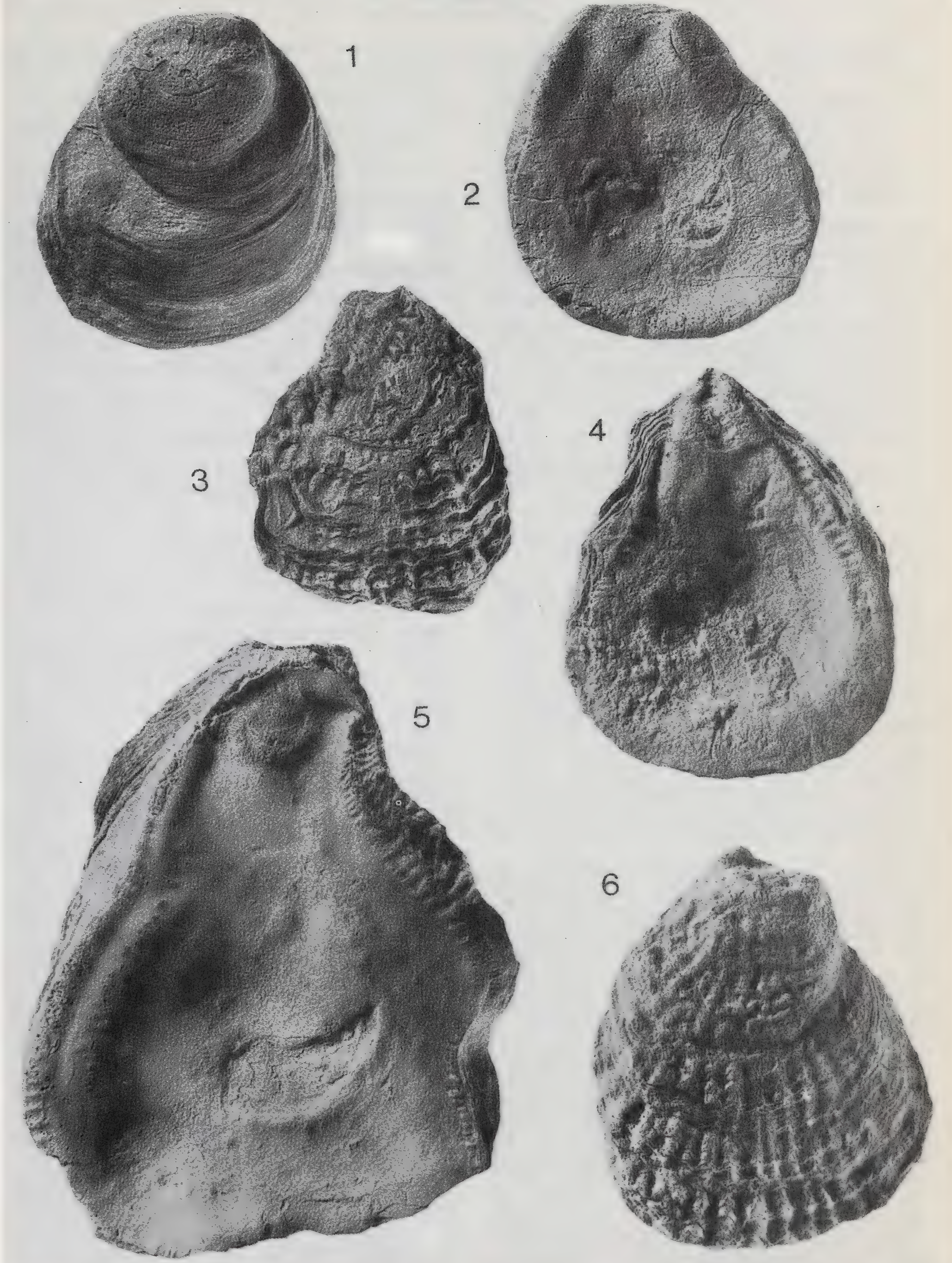

PLATE 4

REVIEW

EYEWITNESS HANDBOOKS. FOSSILS. The visual guide to more than 500 species of fossils from around the world. Cyril Walker and David Ward, Scientific editors. 1992, First American Edition. 320 pp. Dorling Kindersley, Inc., New York. $29.95

A GUIDE TO FOSSILS by Helmut Mayr; translated by D. Dineley, G. Windsor. 1992, English translation of 1985 German edition. 256 pp. Princeton University Press, Princeton, New Jersey. $24.95

These two similar publications are both directed toward the same audience. As an introduction to the amazing array of life forms that have been preserved in the fossil record, either of these books would serve equally well.

I have not seen the original German edition of the Mayr book, but I suspect it was in a larger format than the present "handbook" size (5 x 8 inches), and was more of a "coffee-table" collection of beautiful pictures of beautiful fossils. The illustrations are all specimens in the Bavarian State Collection for Paleontology and Historical Geology, and the majority of the fossils pictured are from Germany (many from Solnhofen, of course). But there are also a number of examples from other parts of the world, including a few from the United States.

In this sense the Walker and Ward book has a more general appeal. Rather than aiming for "beautiful photograph of beautiful fossils," the British book attempts to provide as much information about each selected fossil as possible. On each page there are two examples arranged as though on 3 x 5 inch file cards. Each "card" gives the order, family, "informal name," generic name, generic description, geologic range, distribution, and relative rarity of the genus, plus an illustration of a representative species, with specific name, geologic formation, age, and location for the example. There is even a small reconstruction of what the animal or plant would have looked like in life, with a typical size. In other words, there is a great deal of information crammed into a small amount of space; however, the result is not cluttered.

This is not to say that the German volume does not attempt to provide the same information. For each example, one is given the phylum, class, order, family, and genus. There is a generic description, together with provenance for the genus and distribution for the family. For each example illustrated there is a genus and species name, with geologic age, locality, and size. However, all of this information is in three different places. At the top of the page is the phylum to genus information; at the bottom of the page, the species, age, location, and size of the illustrated object, which is placed on the facing page.

With only approximately 500 examples in either volume, neither is what one might call "comprehensive." And the relative weight given to each phylum is somewhat variable between the two volumes. As an example, the British book devotes 5 pages (10 examples) to graptolites but the German one has only one page (2 examples) for the same phylum. In contrast, the German book has 12 pages (31 examples) of corals while the English one has but 6 pages (12 examples).

Both books have similar introductory parts, with discussions of the nature of preservation, evolution of life through geologic time, how and where to collect fossils, etc. The English book has a more extensive glossary of technical terms, but this is more than made up for in the German volume by schematic drawings of many of the more important classes with morphologic features labeled.

In summary, both books are about the same; there are no obvious differences between them. Both are equally well done from a scientific point of view. But each has a slightly different perspective. If enjoying excellent illustrations of well-preserved fossils is what you want, then the German book is the better. If you are looking for a general overview of every type of life from *Australopithicus* (Pliocene hominid) to *Zosterophyllum* (Early Devonian plant) the English one is the better choice.

–E.H.V.

NON-FUSULINID FORAMINIFERA OF THE UPPER PENNSYLVANIAN FINIS SHALE, INCLUDING THE DESCRIPTION OF AN ENIGMATIC TAXON

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WICHITA FALLS, TEXAS

ABSTRACT

The Upper Pennsylvanian Finis Shale Member of the Graham Formation, Cisco Group (Virgilian Series) can be characterized by its foraminiferal assemblage. Although the chronostratigraphic position of the Finis Shale has been disputed for most of this century, the occurrence of Virgilian age foraminifera supports recent research placing the Finis at the base of the Cisco Group. The mid-unit shales of the Finis contain the highest generic diversity of foraminifera, and also contain an enigmatic taxon, *Finisia martini*, described herein.

Key words: Finis Shale, foraminifera, Pennsylvanian.

INTRODUCTION

The Finis Shale Member crops out in Jack and Young Counties, Texas. The shale may be traced sporatically over an area of approximately 2700 km^2. Foraminifera for this investigation were collected from sites within a 20 km radius of Jacksboro, Jack County, Texas (Text-figure 1).

The study has been undertaken in order to further characterize the chronostratigraphic position of the Finis Shale by providing an account of the foraminifera present. Preliminary investigations of Upper Pennsylvanian foraminifera by Cushman and Waters (1928, 1930) established many genera and species of the Cisco Group, but foraminifera typical of the different stratigraphic members of this group have never been catalogued.

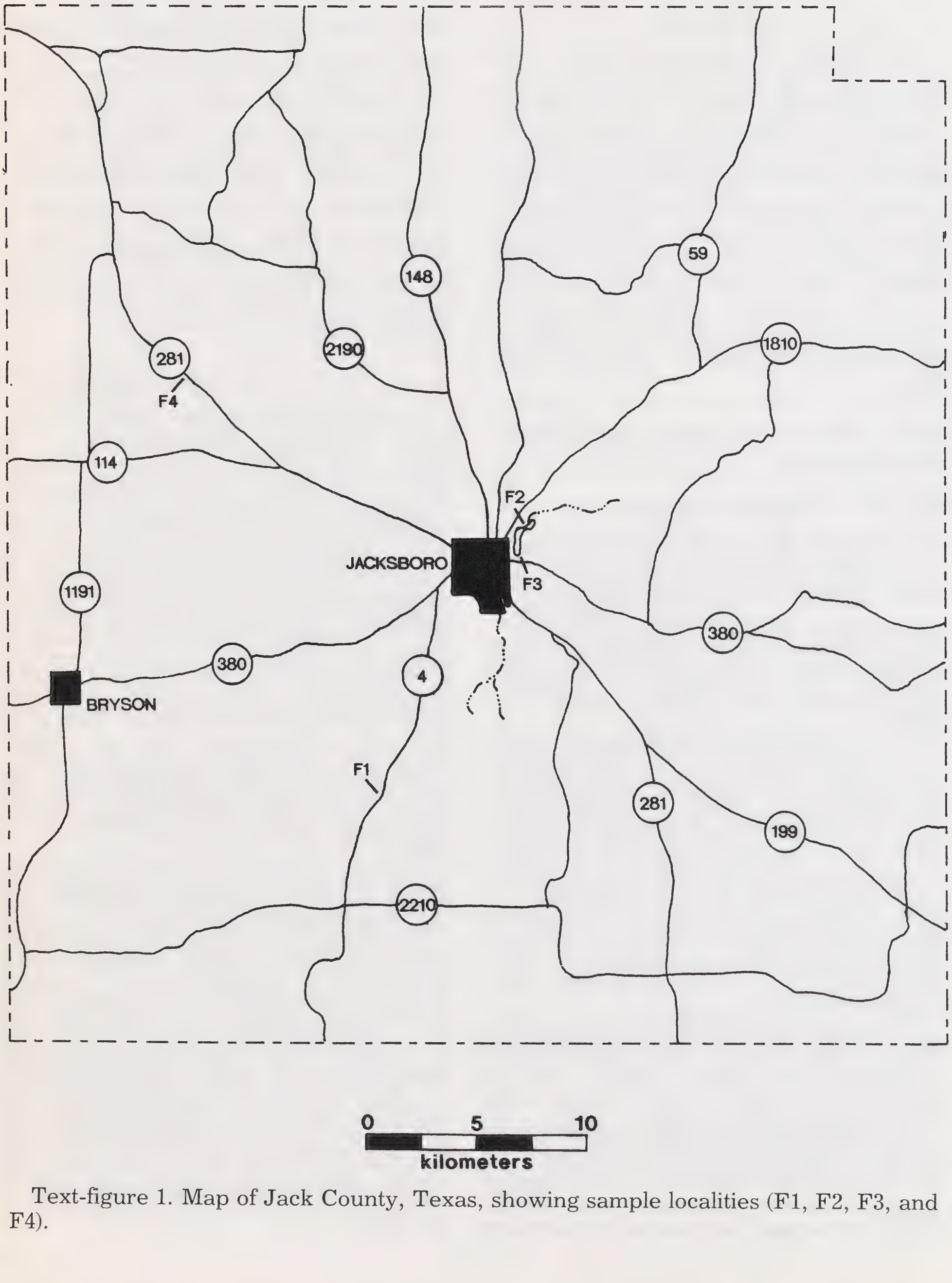
The chronostratigraphic position of the Finis Shale and the overlying Jacksboro Limestone has been a source of controversy for most of this century. The units, indicated in Text-figure 2, were originally defined as the lowermost members of the Graham Formation, Cisco Group, Virgilian Series (Plummer and Moore, 1921). Subsequent researchers considered them as uppermost members of the underlying Caddo Creek Formation, Canyon Group, Missourian Series (Sellards, Adkins, and Plummer, 1932). As a result, literature dealing with these members in northern Texas has often been inconsistent, although recent mapping and biostratigraphic correlations based on ammonoid genera appear to have re-established the Finis Shale and the Jacksboro Limestone as members of the Cisco Group in the Brazos River Valley (Boston *et al.*, 1987; Boston, 1988).

DEPOSITIONAL ENVIRONMENT

The Finis Shale has been interpreted to be the deep-water shale component of a typical Mid-Continental cyclothem (Boardman *et al.*, 1984). Upper Pennsylvanian cyclothems, studied in Kansas, Oklahoma, and Texas (Boardman *et al.*, 1984), contain a transgressive-regressive succession of deep to shallow water units. A generalized cyclothem sequence consists of (base to top) a nearshore shale, a transgressive limestone, a deep-water shale, a regressive limestone, and another nearshore shale (Heckel and Baesemann, 1975; Heckel, 1977; Boardman *et al.*, 1984). Lithologic and faunal changes within the cyclothem are attributed mainly to glacial-eustatic sea level change (Boardman *et al.*, 1984).

Primary stratigraphic and lithologic evidence supporting offshore deposition for the Finis Shale include lateral gradation into other marine, rather than terrestrial units, and the presence of fissile, black, phosphatic shale beds at the base of the unit. The Finis Shale is the only shale unit in north-central Texas known to contain black, phosphatic shale beds (Boardman *et al.*, 1984), and such black shales have been identified as maximum water depth (100-200 m) indicators in other upper Pennsylvanian cyclothems (Heckel and Baesemann, 1975; Heckel, 1977; Boardman *et al.*, 1984).

A depositional model proposes that the phosphatic, black shales found in many mid-continental cyclothems were deposited in anoxic waters below a thermocline, which developed in deeper epicontinental seas (Heckel, 1977; Boardman *et al.*, 1984). A quasi-estuarine type circulation would cause cold, phosphate-rich, oxygen-poor waters below the thermocline to upwell, carrying nutrients for phytop-



Text-figure 1. Map of Jack County, Texas, showing sample localities (F1, F2, F3, and F4).

lankton blooms (Heckel, 1977). Deep water phosphate formation in some modern environments, such as off of the coast of Peru, occurs under similar conditions near oxygen-minimum zones associated with upwelling (Veeh *et al.*, 1973). Subsequent settling and decay of pelagic organisms would perpetuate the cycle, providing phosphate and further depleting bottom-water oxygen content (Heckel, 1977). The black color of the shales and the presence of pyrite in the Finis Shale attest to a high rate of organic decomposition and bacterial interaction (Blatt *et al.*, 1972).

Another indication of low bottom-water oxygen content during deposition is the general lack of benthic fossils in the phosphatic, black shale beds. Most fossils reported from these shales are pelagic or nektonic, such as ammonoids, radiolarians, conulariids, and certain bivalves (Boardman *et al.*, 1984). Compared to the the rest of the unit, the basal black shales of the Finis are sparsely fossiliferous with low diversity at higher taxonomic levels.

Overlying the phosphatic black shales are medium to dark gray shales (2-3 m), which were generally deposited under shallower, oxygenated conditions favorable to a wide variety of taxa. These mid-unit shales contain the highest diversity of invertebrates at higher taxonomic levels. Numerous genera of ammonoids, nautiloids, gastropods, bivalves, brachiopods, bryozoans, crinoids, corals, sponges, and ostracods have been noted (Boardman *et al.*, 1984; Boston, 1988). Low current activity and sedimentation rates enabled *in situ* preservation of many delicate specimens. Alhough bottom waters were probably oxygenated, pyritization of some fossils and the dark color of the shales show reducing conditions prevailed in the upper layers of the sediment (Blatt *et al.*, 1972).

The upper part of the Finis Shale consists of medium to light gray shales (1-2 m) (Boardman *et al.*, 1984; Boston, 1988). These shales are also highly fossiliferous, with pyritization of some specimens, reflecting a depositional environment similar to that of the mid-unit shales. The fossil assemblage, mainly brachiopods, bryozoans, crinoids, and fusulinids, is indicative of yet shallower-water deposition (Boardman *et al.*, 1984). There is a notable increase in fusulinids when compared to the shales of the middle unit.

METHODS AND MATERIALS

As mentioned above, the Finis Shale can be divided into 3 distinct sedimentary units, although all of these units may not be present or well defined at a specific locality (Text-figure 1). A sample of the basal black shales was collected at the F1 locality, a small hill 0.5 km west of Route 4, at a point 10.5 km south of the intersection of Route 380 and Route 4, west of Jacksboro. Three samples of the mid-unit, dark to medium gray shales were obtained from three horizons (F2a, F2b, and F2c) of an outcrop located at the Lake Jacksboro spillway. These shales are now flooded due to a new dam on Lost Creek, which expanded the Lake Jacksboro reservoir. In a roadcut at the southeastern corner of the lake, there is a poorly exposed sequence of the upper unit, medium gray shales (F3). Better samples of the upper shales were collected at

SERIES	GROUP	FORMATION	MEMBER
VIRGILIAN	CISCO	GRAHAM	SOUTH BEND SH
			BUNGER LS
			GONZALES SH
			JACKSBORO LS
			FINIS SH
MISSOURIAN	CANYON	CADDO CREEK	HOME CREEK LS
			COLONY CREEK SH
		BRAD	RANGER LS
			PLACID SH

Text-figure 2. Stratigraphic column of the Upper Pennsylvanian in northern Texas (Brazos River Valley).

the P and S Stone Quarry, located on the south side of Route 281, 16 km northwest of Jacksboro. Sample F4a came from talus piles, and sample F4b came from beds below the contact with the overlying Jacksboro Limestone. Ten kg of matrix from each sample were wet-sieved through a series of screens (0.841, 0.250, 0.149, and 0.074 mm mesh), using Calgon (TM) as a deflocculant. Most of the foraminifera were present on the 0.149 mm mesh screen.

DISCUSSION OF FORAMINIFERAL POPULATION

Foraminifera occur throughout the Finis Shale (Table 1), with three suborders (Textulariina, Fusulinina, and Miliolina) and seven families represented (Loeblich and Tappan, 1988). Since the Finis Shale outcrops in several other localities in Jack and Young Counties, which were not sampled, Table 1 should be considered a representative, though not exhaustive, listing of the foraminifera present.

The basal black shales were nearly devoid of fossils; very few whole microfossils or shell fragments were found in the matrix, as would be expected in a low oxygen depositional environment. The only foraminifera were *Ammodiscus* and *Endothyra,* and these two genera persist throughout the section.

The middle unit, consisting of medium to dark gray shales, has the highest diversity of foraminifera at the generic level, corresponding to the overall maximum faunal diversity reported for this environment (Boardman *et al.*, 1984). In the medium to light gray strata of the upper Finis Shale, generic diversity decreases and the miliolids are not as well represented as they are in the middle unit shales, perhaps in relation to shallower water depths. Both the middle and upper unit shales have attached, porcelanous forms, such as *Ap-*

	LOCALITY								
SUBORDER/ GENUS	BASAL SECTION	MIDDLE SECTION			UPPER SECTION				
	F1	F2a	F2b	F2c	F3	F4a	F4b		
Textulariina									
Ammodiscus	X	X	X	X	X	X	X		
Glomospira		X	X	X					
Glomospirella		X	X	X					
Ammobaculites					X				
Fusulinina									
Paleotextularia			X			X			
Globivalvulina							X		
Endothyra	X	X	X	X	X	X	X		
Tetrataxis		X	X	X	X	X	X		
Miliolina									
Apterinella		X	X	X					
Calcitornella		X	X	X	X	X	X		
Calcivertella		X	X	X	X				
Hemigordius		X	X	X					
Orthovertella		X	X	X					

TABLE 1. Non-fusulinid foraminifera of the Finis Shale. Generic names according to Loeblich and Tappan, 1988.

terinella, Calcitornella, and *Calcivertella,* which are indicative of low current activity and slow sedimentation rates (Loeblich and Tappan, 1964).

The five genera of miliolids prove to be valuable chronostratigraphic indicators. *Calcitornella* and *Calcivertella* are exclusively Virgilian. *Apterinella* begins its range in the Virgilian, and *Hemigordius* ends its range in the Virgilian. Based on the ages of these taxa, the range of *Orthovertella,* which has been considered to end in the Missourian (Loeblich and Tappan, 1988), should be extended to the Virgilian.

SYSTEMATIC PALEONTOLOGY

INCERTAE SEDIS

FINISIA, new genus

Type species: Finisia martini, new species.

Diagnosis: Flattened, elongate test consisting of four external, overlapping chamber-like regions. Small spines around edge of basal chamber-like region, and part way around aperture.

Etymology: Genus named for the Finis Shale member, where the new taxon was found.

FINISIA MARTINI, new species
Text-figure 3

Diagnosis: As for the genus.

Description: Test free, ranging in size from 0.3 to 0.8 mm. Wall calcareous, translucent; pseudosutures horizontal, curved, depressed. Externally, basal chamber-like region with rounded edge; bases of overlapping chamber-like regions flared at sides; final chamber-like region tapering toward rounded terminal aperture. Internally, six to seven evenly spaced longitudinal septae, originating from a thicker side septum (Text-figure 3).

Etymology: Species named for Martin A. Buzas, paleobiologist at the U.S. National Museum of Natural History, in recognition of his continuing foraminiferal research.

Types and occurrence: Holotype, USMN 467523, and paratypes, USNM 467524-467527, are deposited at the NMNH. About 1000 specimens of *Finisia martini* were present in Sample F2c, but none were present in any of the other samples.

Remarks: Since the size and external morphology of *Finisia martini* resemble certain foraminifera, the taxon originally was thought to be a new species of either *Lingulina* or *Frondelina.* However, thin sections revealed an internal wall structure quite different from that of any known foraminifera; internal septae are not horizontal, and do not correspond to the walls of the chamber-like regions visible externally. Instead, internal septae are longitudinal, separating the organism into a series of long, thin internal chambers; hence affinity with the Foraminiferida is doubted (Buzas, pers. comm.). Different taxonomic specialists on fusulinids, ostracods, corals, plants, and *incertae sedis,* associated with the U.S. National Museum examined specimens, thin sections, and photomicrographs of *Finisia martini,* but none were able to categorize the organism within their field of expertise.

CONCLUSIONS

The foraminiferal assemblage of the Finis Shale contains several time-sensitive genera, which are reliable indicators for Virgilian age, information that could prove valuable to subsurface investigations. The distribution of foraminifera throughout the unit concurs with depositional models proposing a deeper-water origin for the Finis Shale, with shallowing upward in the unit. Although the Missourian-Virgilian boundary is presently between the Canyon and Cisco Groups, Virgilian age ammonoids and fusulinids found in the Colony Creek Shale of the upper Canyon Group indicate that the boundary should be placed in the middle of the Canyon Group, at the base of the Ranger Limestone (Boardman and Mapes, 1984). A survey of the non-fusulinid foraminifera present in the Colony Creek Shale may provide additional evidence to support this suggestion.

ACKNOWLEDGMENTS

Thanks are extended to Tracy Schafer, Lorna Obert, and Bill Stephens for their help in the field; to F. Hueber, R. Margerum, W. Sando, G. Sohn, and E. Yochelson (NMNH) for examining the new taxon; to D. Dean (NMNH) for preparing the thin section specimen; to J. Jett (NMNH) for her work on the new taxon; and to M. Buzas (NMNH) for examining the new taxon and reviewing the manuscript.

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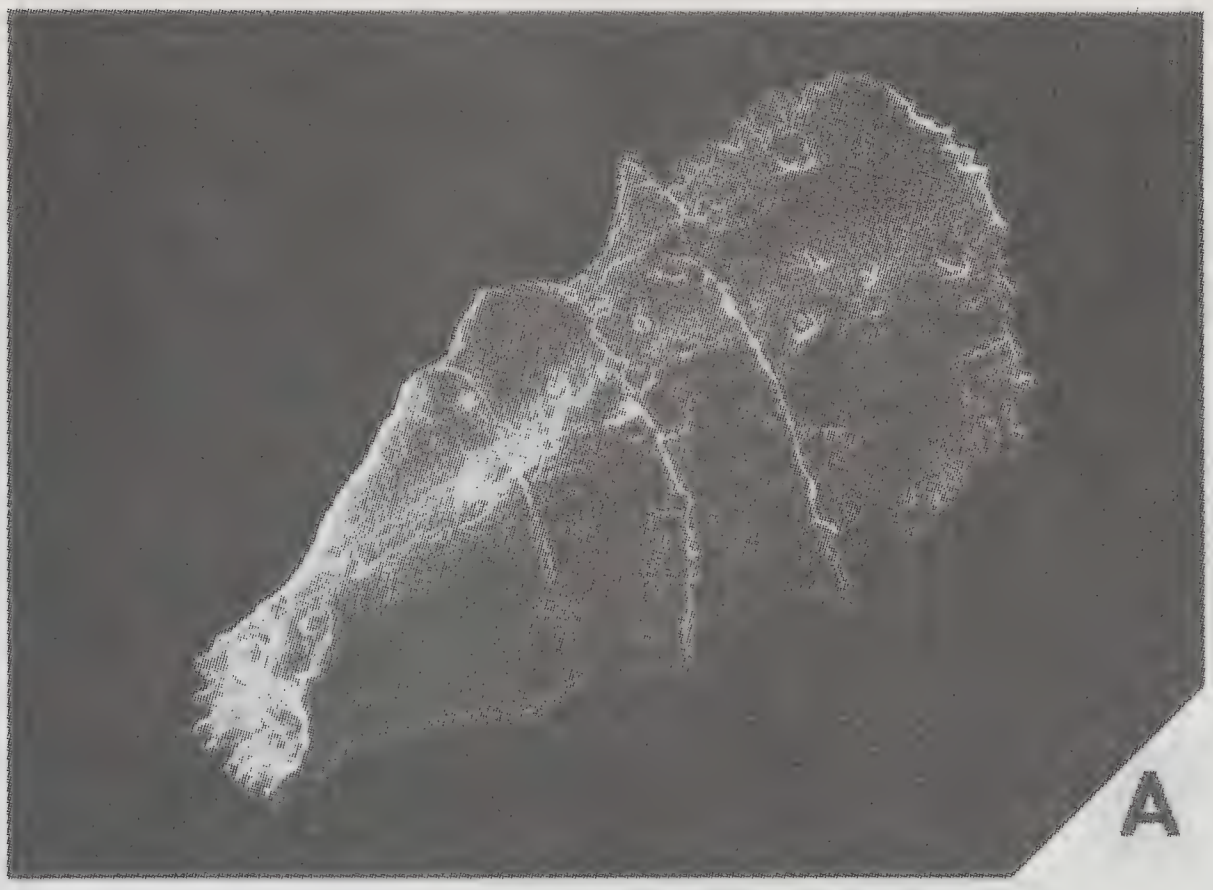
December 29, 1993

Text-figure 3. *Finisia martini*, new taxon. (A) Photomicrograph of holotype (USNM 467523) showing external chamber-like regions (X 215). (B) Longitudinal thin section of paratype (USNM 467524) showing internal septae (X 200). (C) Longitudinal thin section of paratype (USNM 467525) showing internal septae arising from thicker side septum (X 200). (D) Cross-sectional thin section of paratype (USNM 467526) showing internal chambers (X 250).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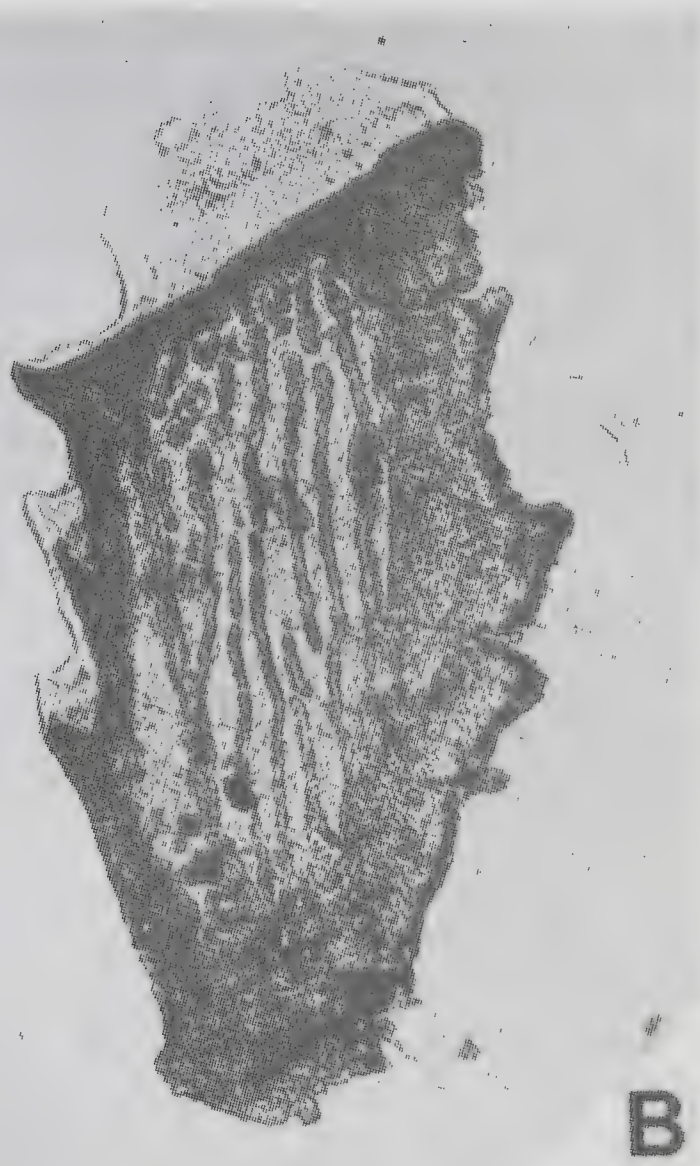
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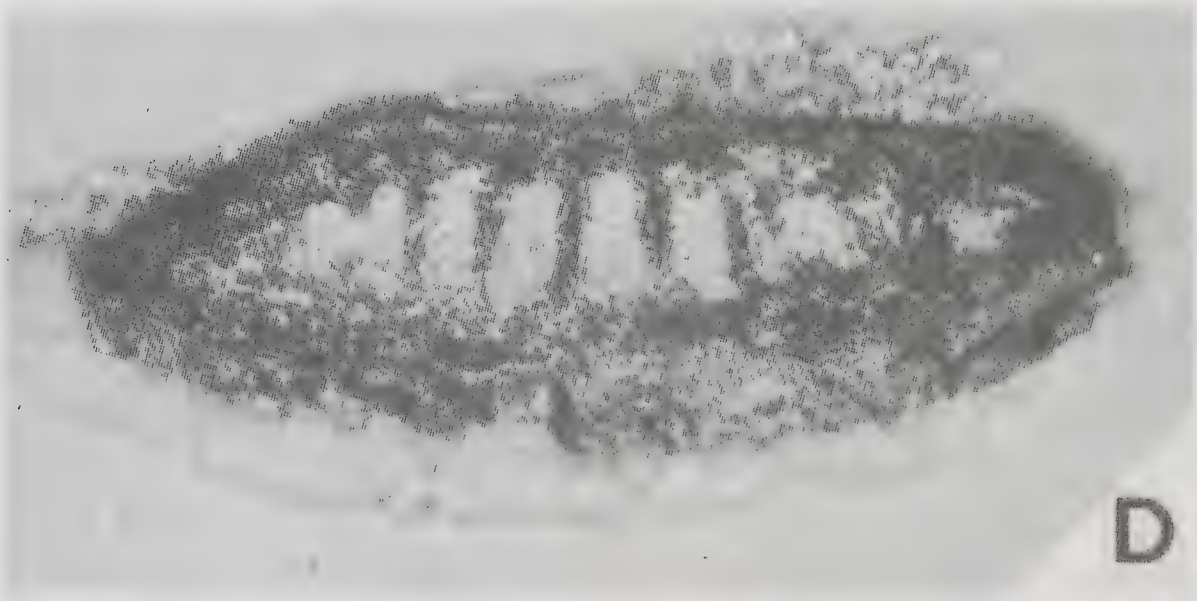
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REVIEW

HANDBOOK OF SYSTEMATIC MALACOLOGY by Johannes Thiele. Published by Smithsonian Institution Libraries and The National Science Foundation, Washington, D.C., 1992, Part 1 (Loricata; Gastropods:Prosobranchia), pp. i-xiii, 1-625; Part 2 (Gastropoda:Opisthobranchia and Pulmonata), pp. i-xiv, 627-1189; 783 text-figs; each volume indexed separately.

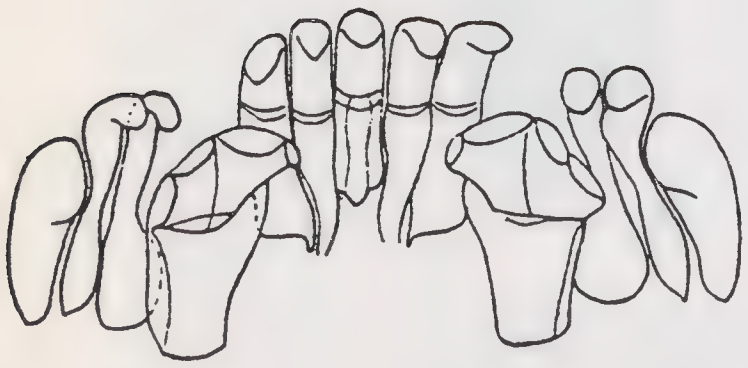
Johannes Thiele (1860-1935) completed his seminal *Handbuch der systematisches Weichtierkunde* (1929-1935) only a few months before his death. It was originally issued in four parts by Gustav Fischer Verlag in Jena. The initial part was published in 1929; following this, Thiele supplied extensive additions and corrections in each subsequent part.

In this work Thiele proposed a systematic classification of the Loricata [Polyplacophora] and Gastropoda that has been the basis for arranging collections throughout the world since his time. Although his classification is now being challenged by current workers, anyone who must deal with the body of systematic literature published since 1935 cannot avoid being influenced by his work.

The German publication was reprinted in its original form in 1963 by A. Asher and Company, Amsterdam, but an English edition has never been available until now. The Smithsonian Institution Libraries, in cooperation with the National Science Foundation, has been involved in a program of translating scholarly subjects since 1960. The new edition of Thiele is the latest offering in this series and was translated from the German by Dr. J. S. Bhatti. The scientific editors were Rudiger Bieler, Field Museum of Natural History, Chicago, and Paula M. Mikkelsen, Harbor Branch Oceanographic Institution, Ft. Pierce, Florida.

In this English Edition the original pagination is indicated in the left-hand margin and the text-figures carry their original numbers. Inserted as footnotes are the additions and corrections provided by Thiele over the years, making this version much more complete than the original text. Any molluscan systematist is already familiar with the contents of this invaluable work. It only needs to be noted that the translation is excellent, as are the reproductions of the figures.

–E.H.V.



EUNICELLA SP., OCTOCORALLIA FROM THE RED BLUFF FORMATION, LOWER OLIGOCENE, MISSISSIPPI

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ABSTRACT

This report represents the first occurrence of *Eunicella* sp., either fossil or modern, found in deposits associated with the Gulf of Mexico. Extension of the distribution of the South African *E. albicans* alliance into the Gulf region is also suggested. The geologic range of Plexauridae is here established as Lower Oligocene to Recent.

INTRODUCTION

Reports of fossil octocorals are becoming more noticeable in the literature as investigators become aware of their presence. Only a few members of the Octocorallia have been recorded from the fossil record. As pointed out by Grasshoff and Zimbrowius (1983, p.112), most "are stored misidentified or as 'enigmatica' in paleontological collections." Occasionally fossil octocorals are recovered that can be assigned to a proper taxonomic position.

The oldest reported octocoral is a sea pen (Pennatulacea), according to Glaessner (1959, 1961). These fossils are part of the late-Precambrian Ediacara fauna and are preserved as impressions. As with many of the Precambrian fossils, some questions still arise as to the true affinity of these forms.

More recently, Lindstrom (1978) reported the oldest gorgonacean from the Lower Ordovician of Sweden. Prior to his article, the geologic range of Gorgonacea was Cretaceous to Recent (Bayer, 1956). For additional information on pre-1956 reports, the reader is referred to Bayer (1956).

Accounts of fossil octocorals from the Cenozoic of the Gulf of Mexico are even more limited. To my knowledge, seven references previously have been made to systematics of fossil octocorals from the Gulf region (Table 1). Representative samples range from sclerites, to axial fragments, to holdfasts. Several octocoral holdfasts have been reported from the Red Bluff Formation (Kocurko, 1988; Kocurko and Kocurko, 1992) but none have been identified.

A perplexing problem for most investigators is the systematic relationships between fossil and modern octocorals. Identification of modern Octocorallia is based primarily on various types of sclerites found in the tissues of the organism. In most cases, a suite of sclerites is needed to identify a single species. Fossil octocorals, however, may not have their sclerite suite intact and their systematic position may be difficult to determine. Fortunately, the genus noted here, from the Red Bluff Formation, is represented by a single, diagnostic sclerite.

STRATIGRAPHY AND SEDIMENTATION

The Red Bluff Formation underlies the Vicksburg Group (Figure 1) and is Lower Oligocene in age (Hazel *et al.*, 1980). The formation has been interpreted as representing a shelf environment based on studies of Bryozoa, Ostracoda, and Octocorallia (MacNeil, 1944; Cheetham, 1963; Hazel *et al.*, 1980; Kocurko and Kocurko, 1992). The study area is located on the east bank of the Chickasawhay River in the SW 1/4 of section 28, T10N, R7W, approximately one km southwest of Hiwannee, Wayne County, Mississippi. Samples were recovered from a fossiliferous, sandy, calcareous shale layer, approximately 2 metres above the base of the formation. The layer contained abundant sandstone and claystone pebbles. The pebbles served as hard substrate on which octocorals attached. Numerous calcified, discoidal holdfasts were recovered from this horizon for subsequent study.

The particular holdfast, here noted, is approximately 9 mm in width and 1.5 mm

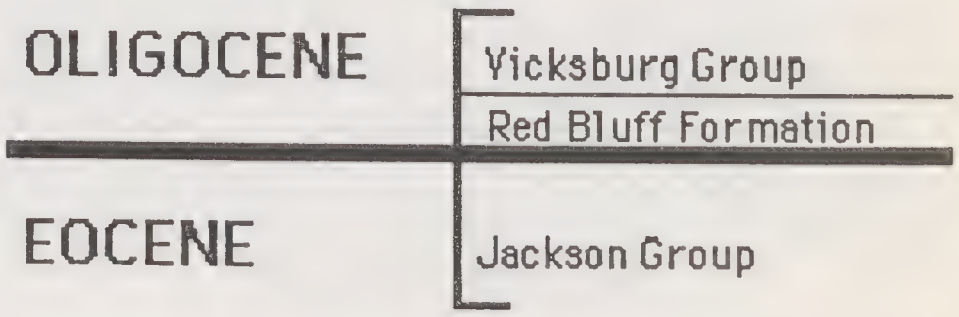

Figure 1. Stratigraphic relationships of the Red Bluff Formation.

TABLE 1. Reports of Cenozoic Octocorallia from the Gulf of Mexico region.

Stratigraphic Unit	**Age/Location**	**Reference**
Unknown	U. Pleist., Yucatan	Kocurko (1988)
Key Largo Ls.	Pleist., Fla.	Kocurko (1988)
Red Bluff Fm.	L. Oligo., Miss.	Kocurko (this report)
Red Bluff Fm.	L. Oligo., Miss.	Kocurko *et al.* (1992)
Red Bluff Fm.	L. Oligo., Miss.	Kocurko (1988)
Jackson Fm. (Gp.)	U. Eocene, Ala.	Cheetham (1963)
Danville Landing Fm.	U. Eocene, La.	Kocurko (1988)
Moodys Branch Fm.	U. Eocene, Miss.	Hickson (1938)
Stone City Fm.	M. Eocene, Tex.	Stenzel *et al.* (1957)
Stone City Fm.	M. Eocene, Tex.	Giammona *et al.* (1980)
Unknown	Eocene, Ala.	Gregorio (1890)

in height. The original specimen was approximately 15 mm in diameter, but only fragments are now available. Microstructures of the holdfast are observable, but poorly preserved.

Associated sclerites were detected after sectioning of the holdfast. Examples were found between laminae of calcium carbonate. During preparation and thin sectioning of the specimen, various laminae of the holdfast were inadvertently disaggregated. The breaking of the specimen exposed numerous sclerites that previously were concealed between the laminae. Sclerites probably were incorporated in the holdfast during sedimentation, after death of the original colony.

Sclerites associated with the holdfast consist of spindles (Figures 2.1-2.4), torches (Figures 2.5-2.6), leaf clubs (Figures 2.7-2.11), a balloon club (Figure 2.12), and wart clubs (Figures 2.13-2.17). Terminology used here is after Bayer *et al.* (1983).

The holdfast was found to contain numerous sclerites that could represent various genera. Sclerite forms suggest similarities to the *Eunicea tourneforti* complex and the *E. mammosa* complex (Bayer, personnal commun.). A particularly diagnostic sclerite is the balloon club (Figure 2.12), assignable exclusively to the genus *Eunicella*.

PALEONTOLOGY

Eunicella is a plexaurid of the order Gorgonacea. The genus is represented by 13 modern species ranging from the Indo-Pacific and western Atlantic (Bayer, 1961) to the Mediterranean (Carpine and Grasshoff, 1975) to southern Africa (Grasshoff, personnal commun.). Fossil representatives of this genus have not been reported from any region or strata prior to this investigation. The geologic range of Plexauridae, and *Eunicella* in particular, is established as Lower Oligocene to Recent.

Eunicella is distinguishable from other octocoral genera on the basis of a unique sclerite referred to as a "balloon club" (Figure 2.12). In general, balloon clubs are smooth to sculptured, domal sclerites. The Red Bluff sclerite, however, has a distinct, medial rim and sculptured dome or head similar to balloon clubs of the modern *E. albicans* complex (Grasshoff, personal commun.). Members of the *E. albicans* alliance, however, presently are found living only in the South African region at a depth of 10 metres (Bayer, personal commun.). It should be noted that there is a discrepancy in the use of the term *alba* vs. *albicans*. It is not within the scope of this investigation to settle a point of nomenclature, and *E. albicans* will be used here. According to Grasshoff (personal commun.) the Red Bluff sclerite is also similar, but not equal, to a deep-water species of the African area. *Eunicella papillosa* has a similar collar structure, but is found in water depths from 25 to 300 metres (Bayer, personal commun.). Sclerites reported from other modern species of *Eunicella* have been compared to the Red Bluff specimen. The collared balloon club clearly can be used to distinguish the sclerite from all other spe-

Figure 2. Sclerites associated with a fossil holdfast from the Red Bluff Formation.

cies except those of the *E. albicans* / *E. papillosa* group.

Relating species on the basis of a single sclerite is at best tenuous but, considering the unique sclerite form, a correlation is suggested. It is likely that *Eunicella* sp. from the Red Bluff Formation represents an equivalent or possible ancestral form of the African group, and should be associated with *E. albicans* and *E. papillosa*.

ENVIRONMENTAL IMPLICATIONS

A previous report of *Eunicella* by Bayer (1961) indicates that modern forms from the western Atlantic are typically found in water depths greater than 360 metres, and none are reported from shallow water. To my knowledge, no species of *Eunicella* has been documented from the Gulf of Mexico (either shallow or deep). This is supported by reports by Giammona (1978) and Bayer (1957). According to Grasshoff (personal commun.), no shallow water species have been reported, accept those of modern Africa.

Eunicella, in the Red Bluff Formation, attached to pebbles by means of a calcified, discoidal holdfast similar to modern forms. The environment of deposition is interpreted to be a moderately shallow shelf with high-energy currents. Most fine-grain sediments apparently were winnowed, resulting in a shelf bottom littered with exposed pebbles and cobbles. Seas of the area, during Tertiary time, have been interpreted as being warmer and more like the Caribbean of today (Giammona, 1978).

CONCLUSIONS

The sclerite described for *Eunicella* sp. differs from most modern forms of the genus. Species that are similar belong to the *E. albicans/E. papillosa* group, and the Red Bluff sclerite may represent an equivalent or ancestral form of this complex. The geologic range of both the genus and the family are extended back to the Lower Oligocene. No reports were found of occurrences of *E. albicans* or *E. papillosa* in the western Atlantic or Gulf of Mexico. The existence of this genus (or these species) in the Gulf of Mexico would indicate that the members of this association were more wide spread during Tertiary time than the modern forms would indicate.

ACKNOWLEDGMENTS

Gratitude is extended to Mr. J. Ketler of Hiwannee, Mississippi for his assistance in locating the study site on his property along the Chickasawhay River. I thank Dr. F. M. Bayer, U.S. National Museum, for his opinions concerning selected sclerites from the Red Bluff Formation. Appreciation is also extended to M. Grasshoff, Senckenberg Museum, for his constructive comments concerning sclerites of the species. I would like to recognize the support and information given by Drs. H. E. and E. H. Vokes, Tulane University.

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December 29, 1993

REVIEW

THE GENUS *CHICOREUS* AND RELATED GENERA (GASTROPODA:MURICIDAE) IN THE INDO-WEST PACIFIC by Roland Houart. Mémoires de Muséum National d'Histoire Naturelle, Zoologie, tome (A) 154, 1992. 188 pp., 480 figs., 4 tables. Price: Dfl 125.00 (about $74.00) plus postage.

Species of the muricid genus *Chicoreus* Montfort are arguably the most beautiful of the family; certainly they are the most numerous in number of species (about 90 world-wide), and, as they frequently occur in shallow water or even intertidal environments, they are well-represented in most collections. They probably are also the most complex of the groups in the Muricinae, as a result of a more than average amount of infra-specific variation.

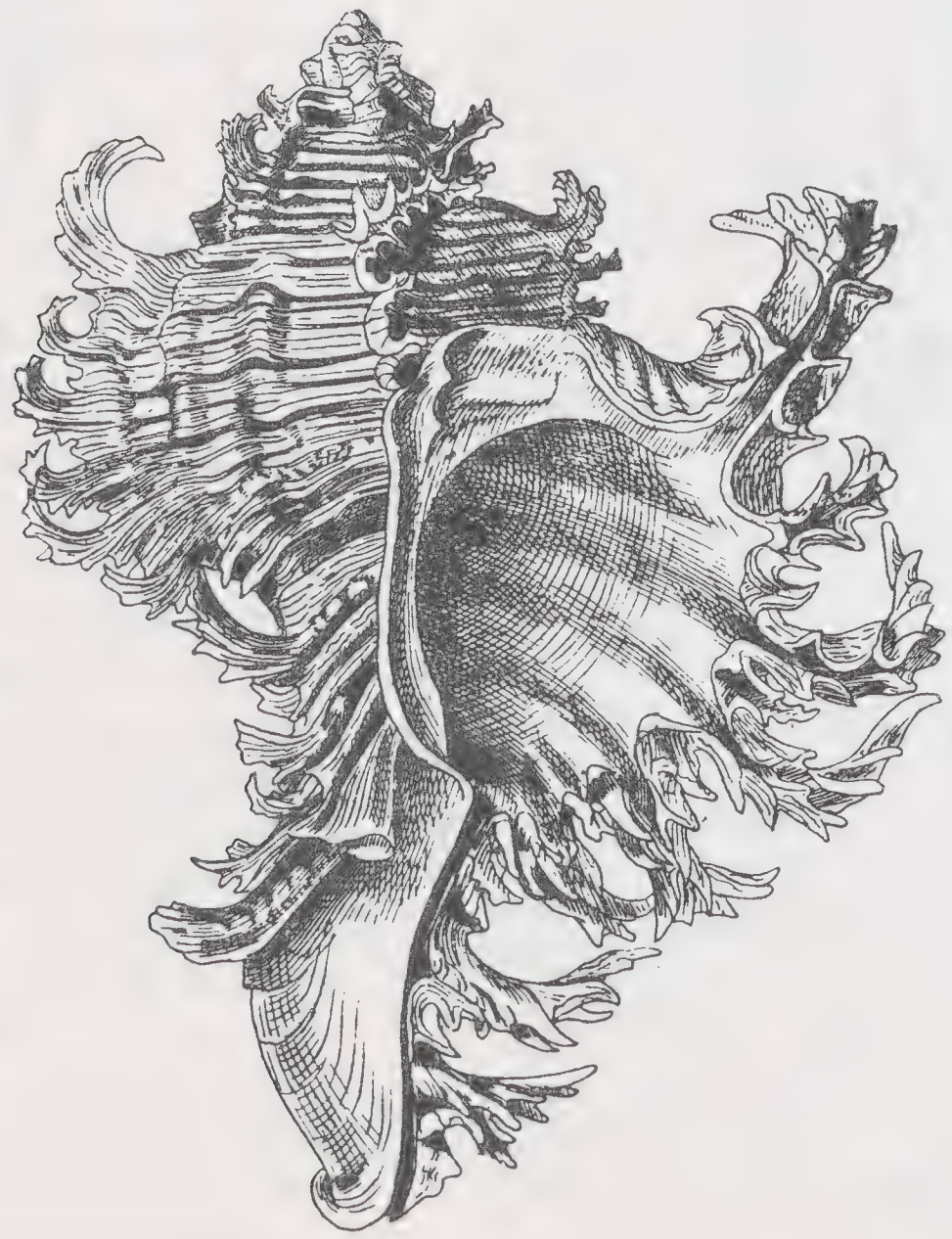
To give an idea of the magnitude of the problem, Houart has accepted a total of 64 Recent taxa in the three genera he is monographing. These 64 species have a total of 77 synonyms between them. One well-known species, *Chicoreus brunneus* (Link), alone has ten synonyms.

To establish these synonymies Houart has done an amazing job of locating type material and, especially, figuring these obscure types. Of the over 400 illustrations of specimens, one third represents type material. But more than that, the illustrations are uniformly well done, and the four plates of color illustrations are especially beautiful.

In addition to the large number of illustrations of specimens there are also distribution maps for each taxon and enlarged drawings of protoconchs for 55 Recent species (often more than one example) and six fossil species.

In summary, Houart has done a superb job of making sense of a complicated group. The general format of the book and its overall excellent quality is a tribute to Philippe Bouchet, of the Muséum National d'Histoire Naturelle, Paris.

–E.H.V.



NOTES ON THE FAUNA OF THE CHIPOLA FORMATION – XXXVI TWO NEW SPECIES OF THE GENUS *CALLIOSTOMA* (GASTROPODA:TROCHIDAE)

GARY W. SCHMELZ
NAPLES, FLORIDA

Since Julia Gardner completed her publications on the molluscan fauna of the Alum Bluff Group of Florida in 1947 many new forms of gastropods occurring in the Chipola Formation have been discovered. Most of these specimens now reside in the Tulane University Collection or are part of the Hoerle Collection at the United States National Museum. An examination of the *Calliostoma* in these collections has revealed the presence of two new species.

According to Hickman and McLean (1990, p. 109) *Calliostoma* is well represented in the Tertiary faunas, where it has demonstrated an increase in diversity from Paleogene to Neogene time. Gardner (1947, p. 617-619, pl. 60, figs. 34, 35, 37 and pl. 62, fig. 5) lists four species of *Calliostoma* from the Chipola Formation. *Calliostoma ceramicum* Dall, 1892, and *Calliostoma grammaticum* Dall, 1892, are relatively abundant species and can be obtained from most Chipola Formation collecting sites. *Calliostoma ceramicum* is quite variable in its shape and sculpture. Maury (1910, p. 150, pl. 25, fig. 4) mistakenly described a juvenile specimen of this species as *Calliostoma palmeri*. In general, adult specimens of this conical shell possess spiral sculpturing of four squarish ribs on the teleconch whorls with narrower channeled interspaces that are crossed by deeply impressed oblique lines, giving the impression that it is covered by roof tiles (Gardner, 1947, p. 619). With *Calliostoma grammaticum* the spiral sculpturing on the teleconch whorls consists of three to five smooth spiral cords arranged in scalar fashion with sharp-cut interspaces (Gardner, 1947, p. 618).

Both *Calliostoma metrium* Dall, 1892, and *Calliostoma exile* Dall, 1892, appear to be less widely distributed throughout the Chipola deposits. *Calliostoma exile* is a small conical species with smooth body whorls (Gardner, 1947, p. 618). In the Tulane collection there is one specimen from locality TU 555, on the Chipola River, and this investigator has obtained one specimen from TU 831 on Tenmile Creek. *Calliostoma metrium*, which reaches a height of 20.5 mm, is a much larger conical shell whose spiral sculpturing on the teleconch whorls consists of fine, closely set, flattened threads (Gardner, 1947, p. 618). In the Tulane Collection five specimens of this species were collected along the Chipola River (four at TU 547 and one at TU 950) and two specimens from Farley Creek (one at TU 825 and another from TU 828).

The two new species of Chipola *Calliostoma* can be easily differentiated from the four other forms described from this formation. Both appear to be limited in their abundance and distribution. One has been exclusively collected from locality TU 555, a former patch-reef environment situated on the east bank of the Chipola River. The second, except for one specimen collected along Farley Creek at TU 819, has been obtained from a short stretch along Tenmile Creek between TU 546 and TU 830. This area represents a deeper-water coastal environment, whose depth is believed to have been between 20 and 30 meters (Vokes, 1989, p. 15).

CALLIOSTOMA SEXTONI Schmelz, n. sp.

Plate 1, figures 1, 2
Text-figures 1, 2

Description: Shell trochoid in shape. Protoconch submerged; about 1 1/2 whorls. Six teleconch whorls; sculpturing on first teleconch whorl consisting of axial threads that later become intercepted by spiral threads. Beaded sculpturing on later teleconch whorls developing at sites where axial and spiral threads intersect; shoulder appearing on fourth teleconch whorl about half-way between sutures. Edge of shoulder sculptured with one spiral row of prominent beads; beads becoming increasingly larger, reaching their greatest dimension on the body whorl. Suture distinct. Between suture and shoulder of body whorl sculpture of two spiral rows of beads, alternating with faint spiral cords. Aperture subquadrate, about one-third height of shell. Outer lip simple. Columella truncate, thickened and arched inward. Umbilicus absent. Base of shell sculptured with eleven spiral cords crossed by faint growth rugae giving a cross-hatched appearance.

Holotype: USNM 476001; height 9.5 mm, maximum diameter 8.3 mm.

Type locality: TU 951; Chipola Formation, Tenmile Creek, about 1 1/2 miles west of Chipola River (SE 1/4 Sec. 12, T1N, R10W), Calhoun County, Florida.

Paratype A: USNM 476002; height 10.5 mm, maximum diameter 9.0 mm; locality TU 546, Tenmile Creek, Calhoun County, Florida.

Additional paratypes: Three specimens from TU 830 (Tulane Collection); three specimens from TU 546 (two from the Hoerle Collection and one from the Tulane Collection); two specimens from TU 998 (Hoerle Collection) and one specimen from TU 819 (Tulane Collection).

Occurrence: Chipola Formation, Calhoun County, Florida.

Discussion: This shell's trochoid shape, beaded sculpturing, subquadrate aperture, truncate and thickened columella clearly indicate that it belongs to the genus *Calliostoma.* Scanning electron microscope (SEM) photographs were taken of the protoconch and early teleconch whorls to see if the characteristic honeycomb pattern was present on the protoconch, in addition to the prominent axial sculpturing on the early teleconch whorls (text-figs. 1, 2). According to Hickman and McLean (1990, p. 109) these are key diagnostic features exhibited by members of the genus *Calliostoma.* The protoconch showed no evidence of the honeycomb pattern, but the typical axial sculpturing was visible. Similar photographs were taken of a second new species described in this paper (text-fig. 3) and identical results were obtained. The absence of the honeycomb pattern on the protoconchs of both shells may have been caused by erosion. It is also possible that the honeycomb pattern did not appear until later in this group's evolutionary development.

Although most of the specimens of *C. sextoni* collected by this investigator, as well as those examined from the Tulane Collection and the Hoerle Collection at the U.S. National Museum, are small, one very large, but incomplete, example of *C. sextoni* was unearthed at TU 830. This specimen, if complete, would measure approximately 17 mm in height and demonstrates that *C. sextoni* achieved a size comparable to larger examples of *C. ceramicum.*

Calliostoma sextoni is a unique species for which the investigator has found no comparable counterparts among fossil or Recent forms. It has been named after Mr. Cecil Sexton in appreciation for his generous hospitality and gracious permission to collect on his property.

CALLIOSTOMA CUSPIDATUM Schmelz, n.sp.
Plate 1, figures 3, 4
Text-figures 3, 4

Description: Shell turbinate in shape. Protoconch submerged; about 1 1/2 whorls. Teleconch with 6 1/2 slightly convex whorls. Sculpturing on first teleconch whorl beginning with wavy axial threads that become intercepted by spiral threads; points where these threads intersect prominent cusp-like beads developed. Body whorl sculpturing of six cusp-like beaded spiral cords, sometimes separated by less distinct beaded spiral threads. Suture indented, but relatively obscure. Aperture subquadrate, about one-third height of shell. Outer lip simple. Columella arched and thickened. Umbilicus relatively narrow. Base of shell slightly convex in adult specimens; sculptured with 13 beaded spiral cords.

Holotype: USNM 476003; height 13.1 mm, maximum diameter 11.3 mm (Hoerle Collection).

Type locality: TU 555; Chipola Formation, east bank of Chipola River, about 1000 feet above Fourmile Creek (SW 1/4 Sec. 29, T1N, R9W), Calhoun County, Florida.

Paratype A: USNM 476004; height 13.8 mm, maximum diameter 12.0 mm; locality TU 555, Chipola River, Calhoun County, Florida (Hoerle Collection).

Additional paratypes: Eighteen specimens from TU 555 (Hoerle Collection) and two broken specimens from TU 555 (Tulane Collection).

Occurrence: Chipola Formation, Calhoun County, Florida.

Discussion: This shell is named for its cusp-like beaded cords (text-fig. 4). There are a number of similar fossil and Recent species. The closest fossil form is *Calliostoma grabaui* Maury (1917, p. 155, pl. 24, fig. 19), from the Late Miocene Cerado

Text-figures 1, 2. *Calliostoma sextoni* Schmelz, n. sp.; USNM 476001 (holotype); locality TU 951.

Text-figures 3, 4. *Calliostoma cuspidatum* Schmelz, n. sp.; USNM 476003 (holotype); locality TU 555.

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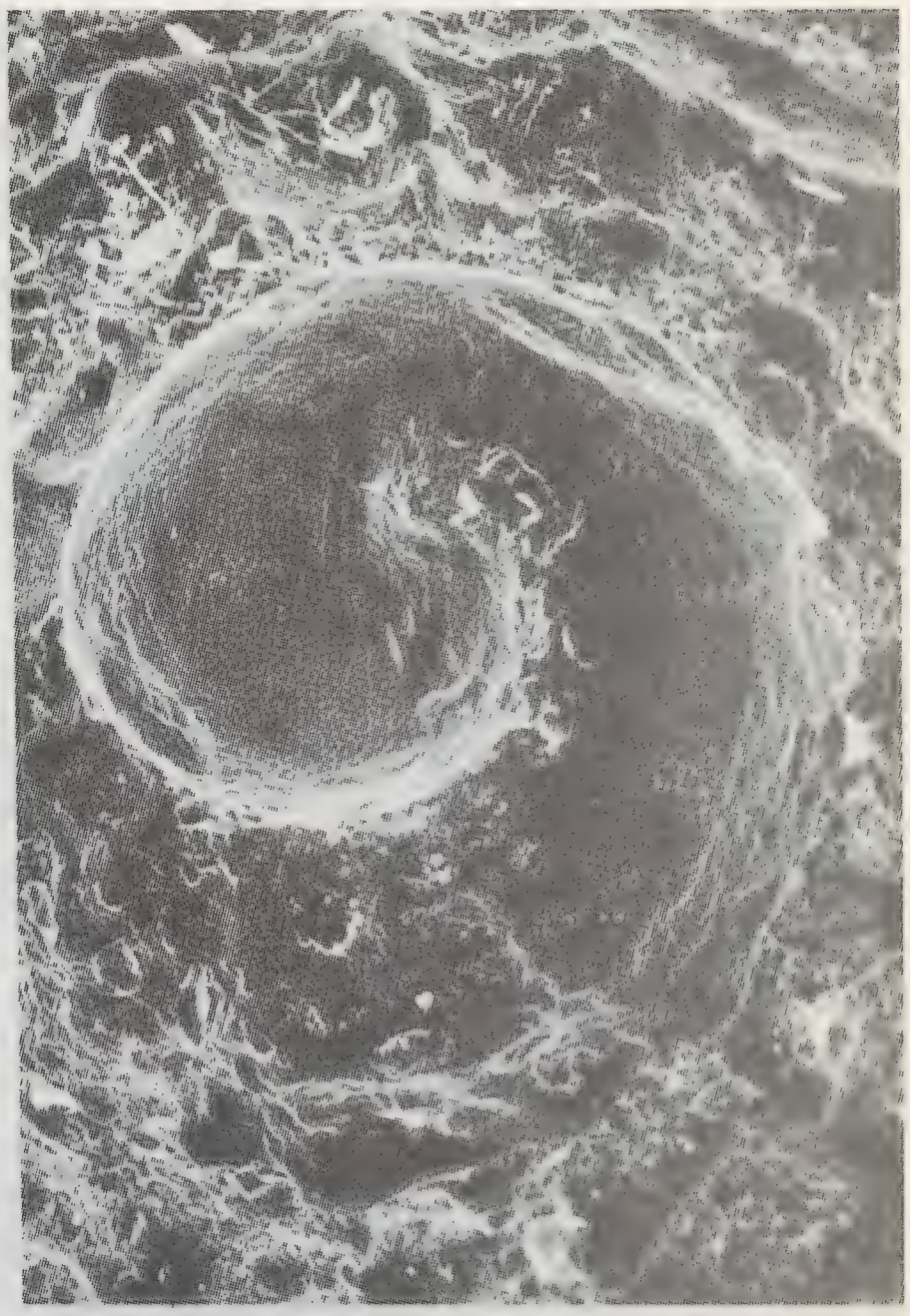

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Formation of the Dominican Republic. The new species differs from the latter in that it has a more pronounced cusp-like beading on the teleconch whorls, a narrower umbilicus, 13 instead of ten spiral cords on the base, and pronounced beading on all of the basal cords.

Two other similar species are *Calliostoma eremum* Woodring (1957, p. 63, pl. 22, fig. 3), from the Pliocene of the middle part of the Gatun Formation near the Panama Canal Zone and *Calliostoma mancinella* Olsson (1922, p. 164, pl. 15, figs. 9, 10), from uncertain age Gatun stage deposits along

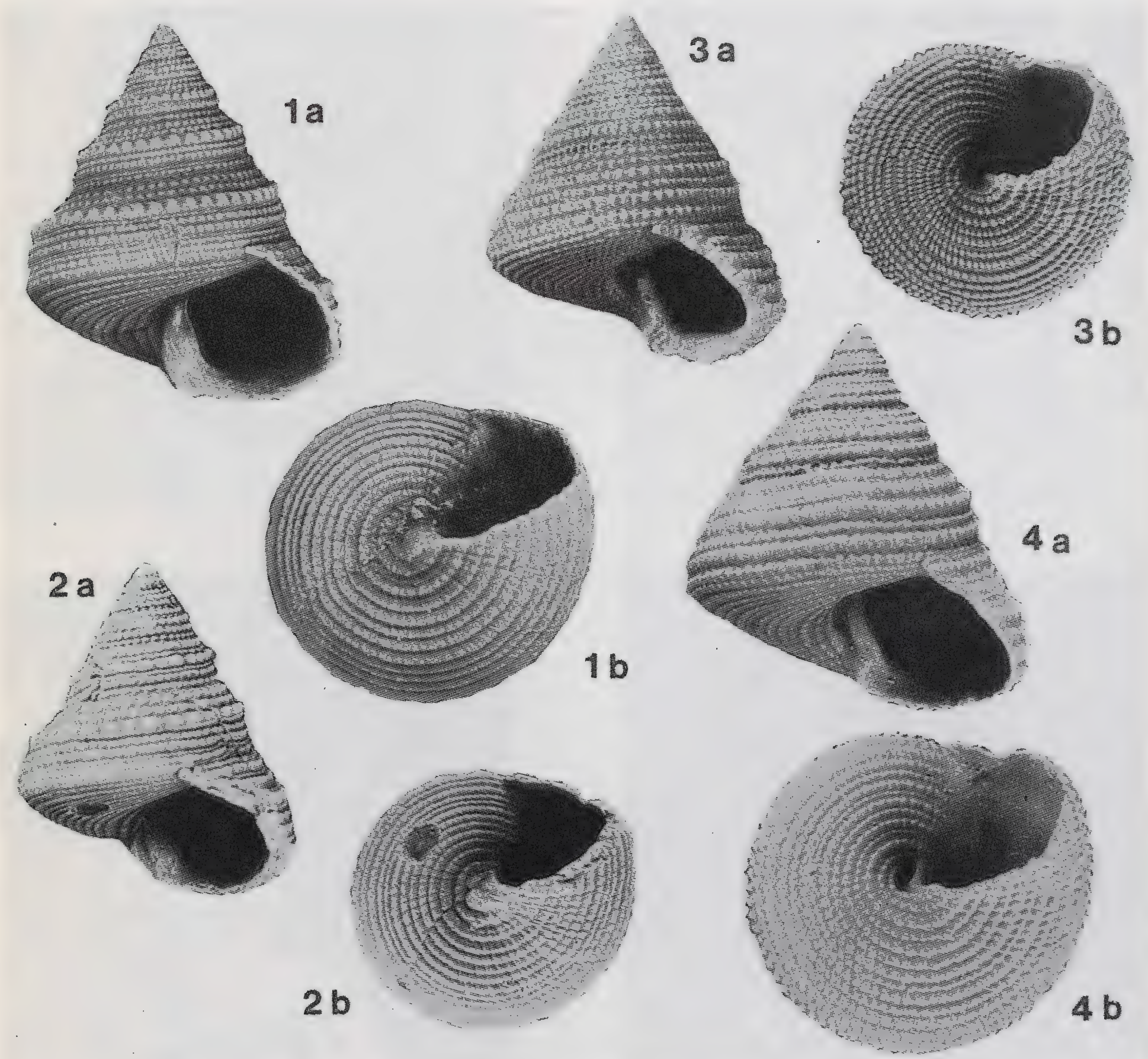

PLATE 1

Figures

1, 2. *Calliostoma sextoni* Schmelz, n. sp. (X 4)
   1. USNM 476001 (holotype); height 11.2 mm, diameter 9.4 mm.
      Locality: TU 951, Chipola Formation, Florida.
   2. USNM 476002 (paratype A); height 9.5 mm, diameter 8.3 mm.
      Locality: TU 546, Chipola Formation, Florida.

3, 4. *Calliostoma cuspidatum* Schmelz, n. sp. (X 3)
   3. USNM 476003 (holotype); height 13.1 mm, diameter 11.3 mm.
      Locality: TU 555, Chipola Formation, Florida.
   4. USNM 476004 (paratype A); height 13.8 mm, diameter 12.0 mm.
      Locality: TU 555, Chipola Formation, Florida.

Old Man Sam Creek in Costa Rica. The new species differs from the former in that it has fewer noded spiral cords on the penultimate whorl (6 compared to 9), a narrower umbilicus and 13 versus 10 or 11 beaded spiral cords on the base.

Compared to the Chipola species, *Calliostoma mancinella* Olsson, 1922, is a squattier, low-spired form whose diameter is greater than its height. It also differs from the new species by possessing a large beaded cord just below the suture of each whorl and has 12 instead of 13 spiral cords on the base. Only four or five of the spiral cords surrounding the umbilicus of this species are beaded; the remaining cords are smooth.

Among present day forms the new species looks most like *Calliostoma euglyptum* A. Adams 1854, listed for the western Atlantic by Clench and Turner (1960, p. 48, pl. 32). It differs, however, from this species in that it lacks an umbilicus, is sculptured with more rounded beaded cords, has 6 1/2 instead of 7 1/2 teleconch whorls, and there are 13 instead of 12 beaded spiral cords on the base.

ACKNOWLEDGMENTS

This investigator would like to extend a special note of thanks to Emily Vokes for the loan of Tulane specimens and her assistance with the photographic work. An additional note of appreciation is extended to the U.S. National Museum and Warren Blow for making specimens from the Hoerle Collection available. This paper could not have been completed without their support.

LOCALITY DATA

The following locations are all in the Chipola Formation, Calhoun County, Florida.

546. Tenmile Creek, about 1 3/4 miles west of Chipola River (NE 1/4 Sec. 12, T1N, R10W) (= USGS 2212, "one mile west of Bailey's Ferry").
547. Chipola River, west bank, about 2000 feet above Fourmile Creek (SW 1/4 Sec. 29, T1N, R9W).
555. Chipola River, east bank, about 1000 feet above Fourmile Creek (SW 1/4 Sec. 29, T1N, R9W).
819. Farley Creek, 0.2 mile west of bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W).
825. Farley Creek, at abandoned mill about 1/4 mile west of bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W).
828. Farley Creek, just upstream from mouth of unnamed tributary about 3/4 mile downstream from bridge of Florida Highway 275 (SE 1/4 Sec. 20, T1N, R9W).
830. Tenmile Creek, at power line crossing about one mile west of Chipola River (SE 1/4 Sec. 12, T1N, R10W).
831. Tenmile Creek (lowest Chipola beds exposed), slightly less than one mile west of Chipola River (SW 1/4 Sec. 7, T1N, R9W).
950. Chipola River, west bank, about 2000 feet above Farley Creek (SW 1/4 Sec. 20, T1N, R9W).
951. Tenmile Creek, about 1 1/4 miles west of Chipola River (SE 1/4 Sec. 12, T1N, R10W).
998. Tenmile Creek, about 1 1/4 miles west of Chipola River (SE 1/4 Sec. 12, T1N, R10W).

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NOTES ON THE FAUNA OF THE CHIPOLA FORMATION - XXXVII
VARIATION IN THE SHELL MORPHOLOGY OF *CALLIOSTOMA CERAMICUM* (GASTROPODA:TROCHIDAE)

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Over two hundred specimens of *Calliostoma* were collected "in situ" from locality TU 951 along Tenmile Creek in Calhoun County, Florida. The majority were *Calliostoma ceramicum* (Dall, 1892). An examination of this species reveals a high degree of variation in shell morphology. In at least one instance, the shell structure and sculpture of *C. ceramicum* differed so much from the holotype that this investigator was tempted to identify it as a new species. The purpose of this note is to document the degree of variability of *C. ceramicum*.

Calliostoma ceramicum was initially described by Dall (1892, p. 404, pl. 18, fig. 10) from a specimen collected on Tenmile Creek. Dall characterized the species as a distinctive form that possesses an umbilicus and has tile-like sculpturing on the body whorls, the latter being created by four squarish ribs that are crossed by numerous, deeply-impressed, oblique lines. Later, Maury (1910, p. 32, pl. 8, fig. 4) identified a smaller specimen of *C. ceramicum* as a new species and named it *C. palmeri*. This specimen has finely beaded spiral whorls. Gardner (1947, p. 619) listed *C. palmeri* as a form of *C. ceramicum*, noting that it is probably a juvenile of *C. ceramicum*.

According to Hickman and McLean (1990, p. 109) it is best to study the mouth parts, radula and marginal teeth when identifying different species of *Calliostoma*. Since there are no fossil records of these features, researchers must determine their identification of any new fossil species of this genus through a careful analysis of its different structural forms. In the case of *C. ceramicum* such a study helped reveal a wide range of variability in shell structure, including differences in the shape and sculpture of the body whorl and an occasional closure of the umbilicus by the parietal shield.

Pictured on plate 1, figures 1-5, are representative examples of the different morphological types of *C. ceramicum* collected at TU 951. Figure 1 depicts a specimen that closely resembles the holotype of *C. ceramicum*, as described by Dall. This shell possesses a well-developed umbilicus and has the "tile-like" sculpturing on its body whorls. Figure 2 shows a juvenile specimen, which illustrates the finely beaded spirals, especially in the early whorls, of Maury's *C. palmeri*. The shell shown in figure 3 is similar to Dall's holotype but lacks an umbilicus. Figure 4 shows a shell that does not have the pronounced "tile-like" sculpturing of the holotype and has a single row of beaded ribs above and below the suture in the later whorls. The most radical departure from the holotype is the shell illustrated in figure 5. This specimen lacks an umbilicus, has straight sided body whorls and lacks the pronounced tile-like sculpturing on the body whorl.

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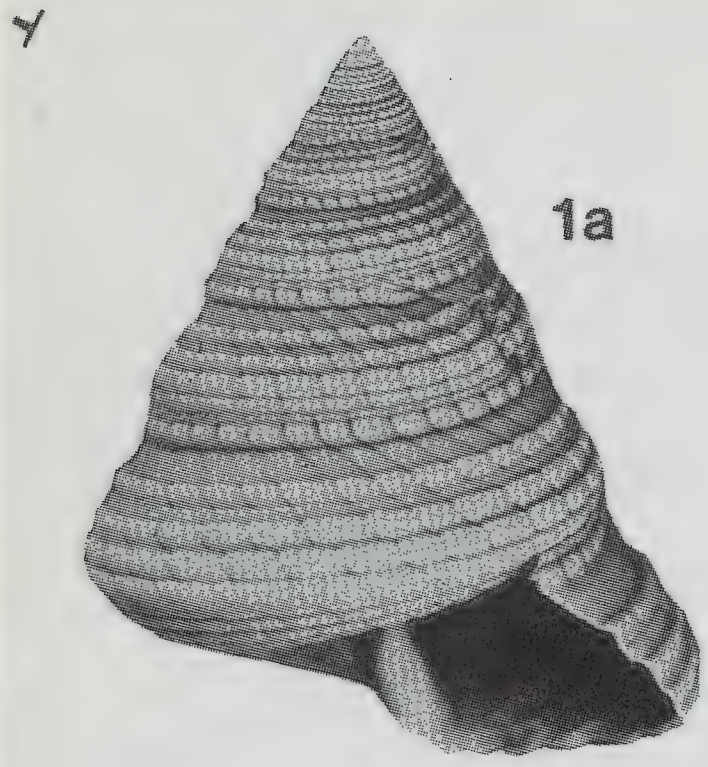
Text-figures 1-5. Different morphological types of *Calliostoma ceramicum* Dall. Fig. 1, height 16.4 mm. Fig. 2, height 8.8 mm. Fig. 3, height 15.5 mm. Fig. 4, height 14.9 mm (apex missing). Fig. 5, height 17.9 mm. All specimens from locality TU 951, Tenmile Creek, about 1 1/4 miles west of Chipola River, Calhoun County, Florida.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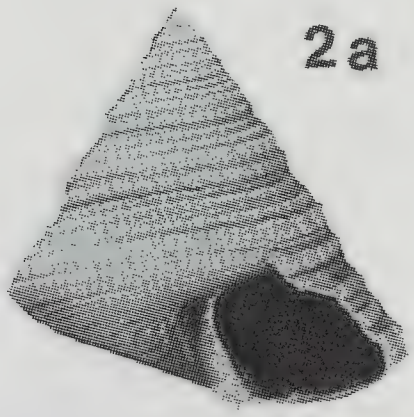
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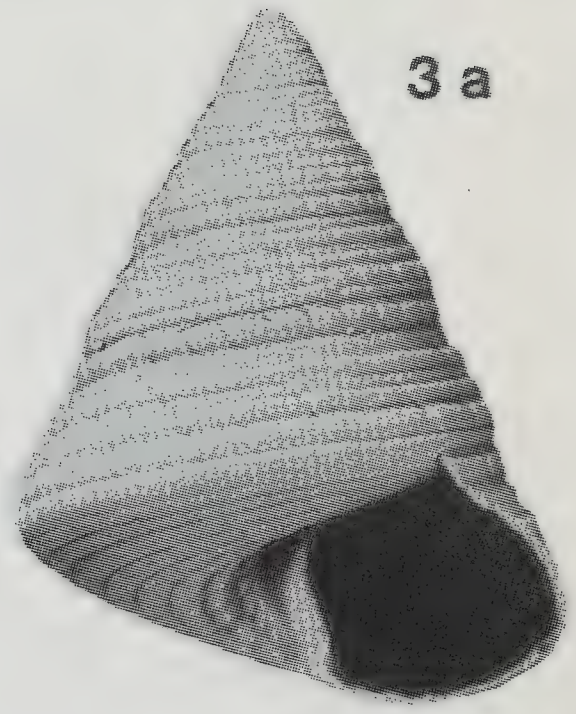
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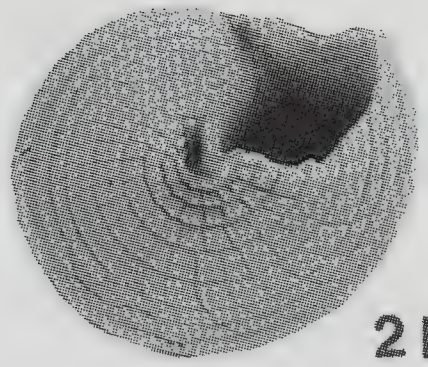
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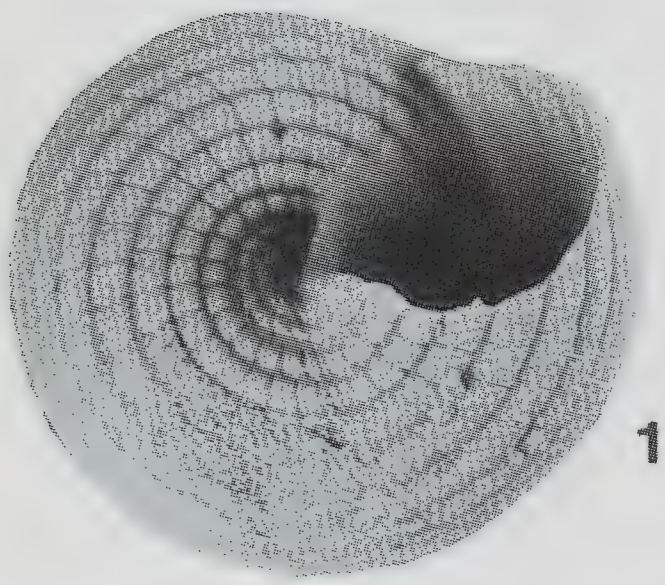
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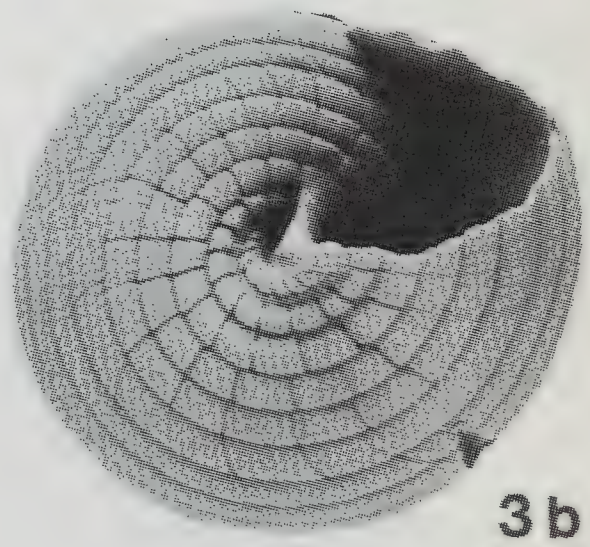
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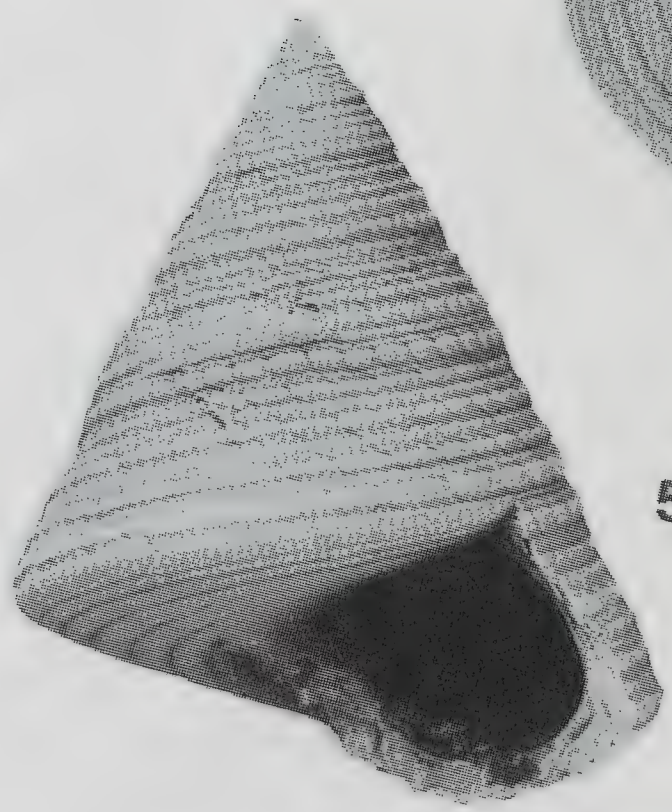
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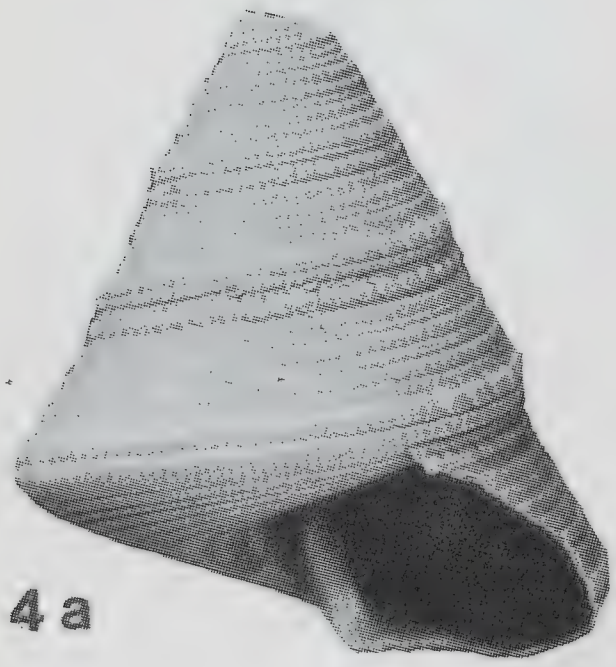
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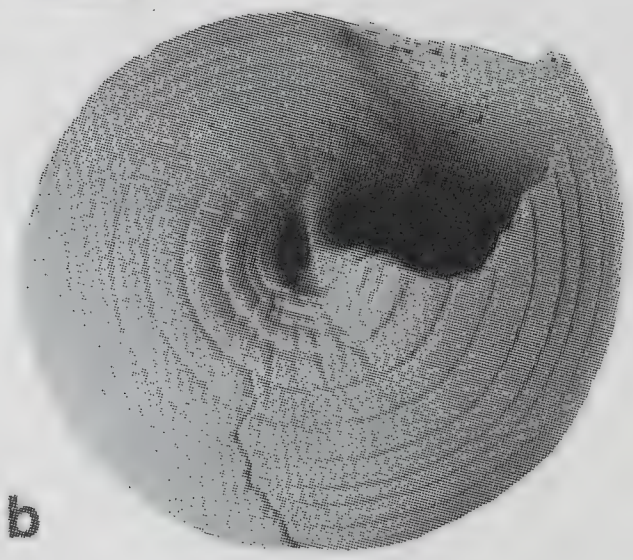
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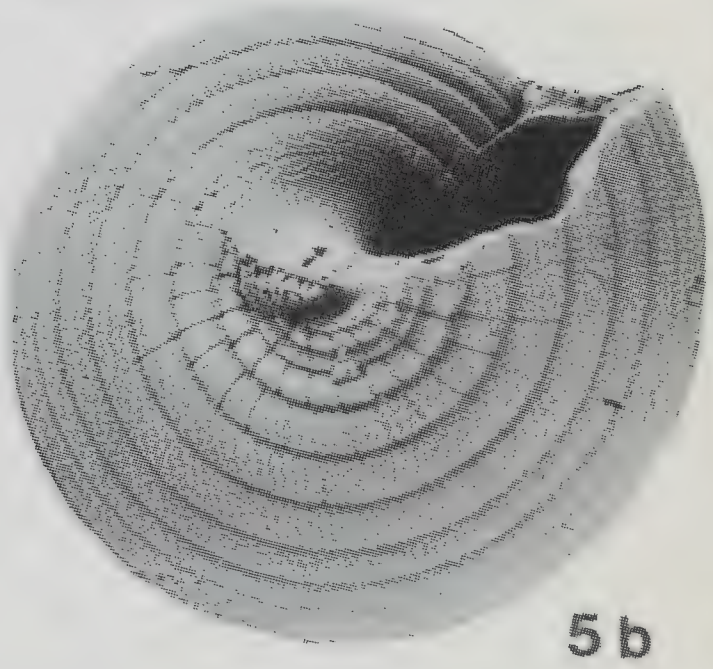
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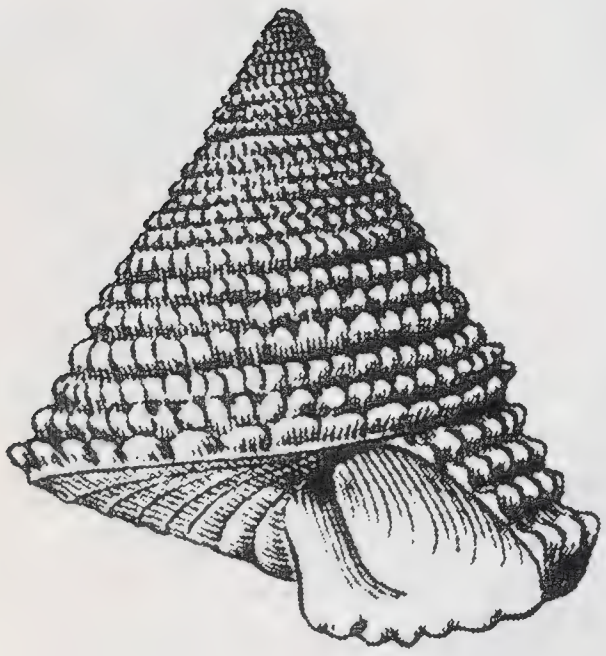

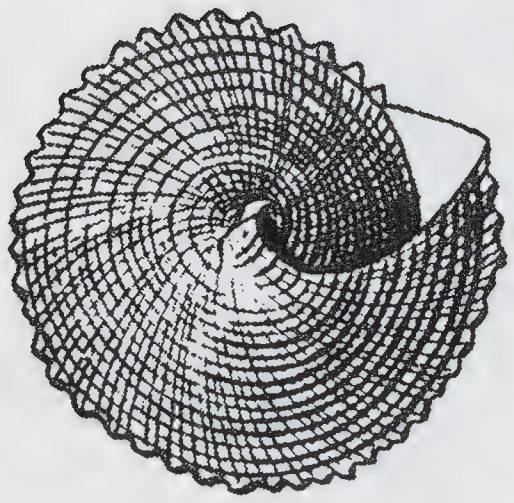

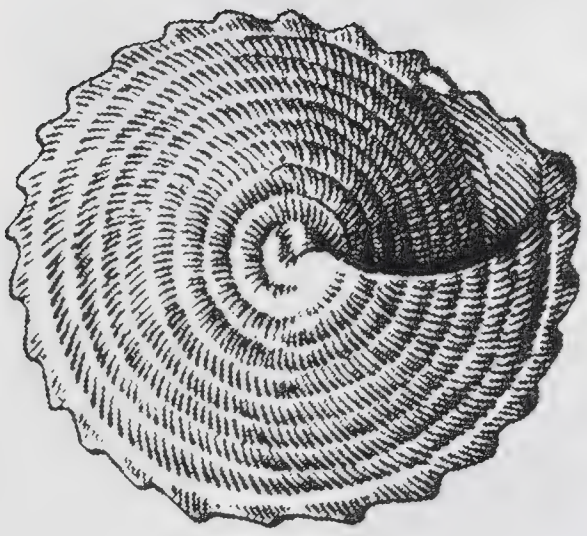

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Volume 26, Numbers 2-4 May 25, 1994

CENOZOIC MURICIDAE OF THE WESTERN ATLANTIC REGION PART X – THE SUBFAMILY MURICOPSINAE

EMILY H. VOKES
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I. ABSTRACT

The muricid subfamily Muricopsinae includes a total of 88 named taxa, of which 74 are considered valid. This number includes 12 new species described herein, from either fossil or living material in the western Atlantic. There are ten genus-groups recognized: six genera and four subgenera, with a maximum of 20 to a minimum of one species included in each. New species described include three from the Early Miocene Chipola Formation: *Muricopsis (Muricopsis) shirleyae*, *?Murexsul nanissimus*, and *Murexiella (Murexiella) parvula*. There are four Recent species: *Muricopsis (Muricopsis) josei* and *Muricopsis (Muricopsis) marcusi*, both from Brazil; *Muricopsis (Muricopsis) perexigua*, from the Caribbean and the Bahama Islands; and *Favartia (Favartia) barbarae*, from off Yucatan, Mexico. The other new species are: *Murexsul comptulus*, Waccamaw Formation, South Carolina; *Murexsul amphilogos*, Moín Formation, Costa Rica; *Murexiella (Murexiella) petuchi*, Pinecrest beds, Florida; *Murexiella (Murexiella) stephensae*, (?)Tamiami Formation, Florida; and *Favartia (Caribiella) carmenae*, (?)Medias Aguas Formation, Veracruz, Mexico. An additional nine forms are cited only as "sp.," making a total of 83 taxa treated systematically in this report.

II. INTRODUCTION

The subfamily Muricopsinae is among the most recently recognized groups within the family Muricidae. In 1971, at a meeting of the Western Society of Malacologists, I presented a paper (Vokes, 1971b) on the geologic history of the family Muricidae, in which I concluded that in the subfamily Muricinae there are three distinct lineages: one, the *Paziella-Poirieria-Pterynotus* branch; two, the *Hexaplex-Murex-Chicoreus* branch; and three, the *Murexiella-Murexsul* branch. All three go back to the beginning of the Tertiary, with numerous species in each group being present in Eocene strata world-wide.

At the same meeting Radwin and D'Attilio (1971) presented a systematic arrangement of the entire superfamily Muricacea, separating the various species into subfamilies based upon the shell, the operculum, and, especially, the radula. In this arrangement they retained two branches of my subfamily Muricinae (the *Paziella* "clan" and the *Hexaplex* "clan," as I termed them), both of which have a flat rachidian tooth, in the subfamily Muricinae, but the third (the *Murexiella-Murexsul* "clan") they placed into a new subfamily based primarily upon the presence of a very different three-dimensional rachidian tooth (see Radwin and D'Attilio, 1971, figs. 21, 22, 23).

Having already noted that each of the three groups has been extant for approximately the same length of geologic time, and considering the evidence of the markedly different radular types, I immediately accepted the new subfamily Muricopsinae.

This group is not as large in numbers of species, or genera, as the other two branches. However, the species are widespread throughout the world both in the geologic record and in the Recent fauna. In previous publications on western Atlantic members of Muricidae, most generic groups now placed in the subfamily Muricopsinae have been monographed, but not all. Furthermore, some were done originally as early as 1968, before the "explosion" of new species reported in recent years. Thus, it is appropriate that a study be undertaken encompassing all the western Atlantic species of the subfamily.

The previous studies, listed in the systematic order used in the present paper, are as follows:

Muricopsis s.s. – never done.
Muricopsis (Risomurex) – Vokes and Houart, 1986
Murexsul – Vokes, 1968
Acanthotrophon – Vokes, 1980
Murexiella s.s. – Vokes, 1968
Murexiella (Subpterynotus) – Vokes, 1968
Homalocantha – Vokes, 1968 (as species of *Murexiella*)
Favartia s.s. – never done
Favartia (Caribiella) – never done
Favartia (Pygmaepterys) – Vokes and D'Attilio, 1980

In the present study a total of 83 species is treated. These are divided rather evenly between fossil and Recent forms. The numbers of species in each genus-group occurring only as fossils compared with those occurring only in Recent faunas, and those occurring both fossil and Recent, are presented in Table 1.

I have attempted to make synonymies for fossil species as complete as possible. However, for Recent species generally the citations are only to references where the form was illustrated. Unless the citation notably extends the range or affects the nomenclature it is not included. For many of these common western Atlantic species a "complete" synonymy would include a great many references to simple faunal lists.

III. ACKNOWLEDGMENTS

Some of the work in this paper was done as long ago as my doctoral dissertation (1967) and, as a result, over the years there have been a very large number of persons who have provided assistance in the form of specimens for study (both as loans and as outright gifts), information, and photographs. In particular, workers at several institutions have been extremely helpful, both lending type material and providing information on type specimens. These would include the United States National Museum of Natural History (M.G. Harasewych, Raye Germon, Thomas R. Waller, Warren Blow), the Academy of Natural Sciences of Philadelphia (Robert Robertson, Gary Rosenberg, David G. Robinson,

TABLE 1. DISTRIBUTION OF WESTERN ATLANTIC SPECIES OF MURICOPSINAE BY GENUS-GROUP

Genus	Fossil only	Fossil and Recent	Recent only	Total
Muricopsis	6	1	7	14
Risomurex	3	2	5	10
Murexsul	6	1	2	9
Acanthotrophon	2	1	1	4
Murexiella	11	6	3	20
Subpterynotus	1	0	0	1
Homalocantha	3	0	0	3
Favartia	2	3	6	11
Caribiella	1	0	1	2
Pygmaepterys	2	1	6	9
Total	37	15	31	83

Nancy W. Rulon, Doree Bardes), the Museum of Comparative Zoology, Harvard University (Kenneth J. Boss, Fred Collier), Carnegie Museum of Natural History (John E. Rawlins), Florida Museum of Natural History (Roger W. Portell), Florida Dept. of Natural Resources (William G. Lyons), Museu Oceanográfico, Rio Grande do Sul (E.C. Rios), Muséum National d'Histoire Naturelle, Paris (Philippe Bouchet, Virginie Heros), and the Naturhistorisches Museum, Basel, Switzerland (Peter Jung).

A large number of individuals generously have provided me with specimens for figuring, for use as types, and general comparative material. First among these would have to be Susan B. Stephens (Sanibel, Florida), the late Barbara Steger (Tampa, Florida), and Kevan and Linda Sunderland (Sunrise, Florida). But close behind comes a virtual army of collectors (both professional and amateur) who I am listing in alphabetical order; all have been extremely helpful in this study. They are: Jose and Marcus Coltro (São Paulo, Brazil); David T. Dockery III (Mississippi Department of Environmental Quality); Paul Drez (Albuquerque, New Mexico); James Ernest (Balboa, Panama); Jose Espinosa (Havana, Cuba); Emilio Garcia (Lafayette, Louisiana); Mr. and Mrs. Jack Gibson Smith (Surrey, England); David Hargreave (Kalamazoo, Michigan); the late Shirley E. Hoerle (West Palm Beach, Florida); Roland Houart (Landen, Belgium); Susan Khan (New Port Richy, Florida); Maria del Carmen Perrilliat (Instituto de Geología, UNAM, Mexico); Edward J. Petuch (Florida Atlantic University, Boca Raton); Gary W. Schmelz (Naples, Florida); Donald R. Shaskey (Redlands, California); Judith Terry Smith (Palo Alto, California); Danker Vink (formerly of Curaçao, Netherlands Antilles); John S. Waldrop (Lake Wales, Florida); Druid Wilson (Lake Wales, Florida); and the late Eugenia I. Wright (Phoenix, Arizona). If I have omitted anyone, I apologize.

Finally, Hubert C. Skinner took on the monumental task of editing the manuscript, thereby earning my undying gratitude.

Abbreviations for Repository Institutions:

ANSP – Academy of Natural Sciences, Philadelphia, Pennsylvania, USA

CMNH – Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, USA

IRSNB – Institut Royal des Sciences Naturelle, Bruxelles, Belgium

MCZ – Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, USA

MNHN – Muséum National de Histoire Naturelle, Paris, France

MORG – Museu Oceanográfico, Rio Grande, Rio Grande do Sul, Brazil

NMB – Naturhistorisches Museum, Basel, Switzerland

PRI – Paleontological Research Institution, Ithaca, New York, USA

SDNHM – San Diego Natural History Museum, San Diego, California, USA

UF – Museum of Natural History, University of Florida, Gainesville, Florida, USA

USNM – U. S. National Museum of Natural History, Washington, DC, USA

IV. SYSTEMATIC PALEONTOLOGY

Family MURICIDAE Rafinesque, 1815
Subfamily MURICOPSINAE Radwin and D'Attilio, 1971
Genus MURICOPSIS Bucquoy and Dautzenberg, 1882
Subgenus MURICOPSIS ss.

Muricidea "Swainson" of authors, *not* of Swainson, 1841.

Type species: *Murex hexagonus* Lamarck, 1816, by "subsequent designation," Jousseaume, 1880.

Muricopsis BUCQUOY and DAUTZENBERG *in* BUCQUOY, DAUTZENBERG, and DOLLFUS, 1882, Moll. Mar. Roussilon, v. 1, p. 19.

Type species: *Murex blainvillei* Payraudeau, 1826, by original designation.

Discussion: The name *"Muricidea"* was used for this group for many years after the name *Muricopsis* was proposed for those shells typified by *Murex blainvillei*. The genus *Muricidea* was proposed originally by Swainson with the type species *Murex magellanicus* Gmelin, 1791, thereby creating a synonym of the genus *Trophon* Montfort, 1810, the type species of which is also *M. magellanicus* (= *Buccinum geversianum* Pallas, 1774). This type designation was ignored by subsequent writers and the type, by "consensus," was taken to be

Murex hexagonus Lamarck, 1816 (*non Murex hexagonus* Gmelin, 1791). In much of the literature until as recently as 1953 (M. Smith) the name *Muricidea* was employed for shells that we would refer to *Muricopsis*.

The gender of the generic name *Muricopsis* has been the subject of debate. The problem is that the suffix "*-opsis*," meaning "having the appearance of, like" is derived from the Greek noun "*opsis, opseos*," meaning "look, appearance, face." According to Roland Brown (1954, p. 483), the historic spokesman for scientific nomenclature: "Generic terms ending with the noun *opsis* are feminine; but those in which *opsis* is adjectival may, in practice be masculine, feminine, or neuter, in accord with the genders of the governing name." Hence, as *Murex* is masculine, the derivative name *Muricopsis* – "with the appearance of, or looking like a *Murex*" would be considered masculine, as it generally has been treated by those few authors who have considered the taxon as a genus and not just a subgenus of the masculine *Murex* (*e.g.*, Cossmann, 1903; Radwin and D'Attilio, 1976; Vokes and Houart, 1986).

However, Brown goes on to add: "The many current exceptions...emphasize the need for a guiding principle." The *Code of Zoological Nomenclature* (Third Edition, 1985) has, indeed, settled this matter in Article 30(a), which states that the gender of a Latin or Greek word is that given in a standard Latin or Greek dictionary. Among the examples given is the termination *-opsis*, which they note is feminine. Therefore, the names in this study have been emended accordingly.

The genus *Muricopsis* is characterized by a marked biconic shape, the posterior edge of the aperture falling almost exactly on the mid-point of the height of the shell. There are five or six strong denticles on the inner side of the outer lip and, in the type species and the geologically older New World species, there are two strong denticles on the anterior portion of the columellar lip. However, in the younger New World species, these are commonly either reduced or lacking. The spiral ribs number three to five and give rise to short, pointed spines where they cross the varices, which are about seven in number. All of the Recent species are much alike whether they are in the Mediterranean, the western Atlantic, or the eastern or western Pacific. The oldest known species definitely referable to the genus *Muricopsis* s.s. is *M. vistaensis* Givens and Kennedy (1976, p. 969, pl. 3, figs. 1-6), from the Eocene of California.

In the western Atlantic the oldest known species referable to *Muricopsis* s.s. is the Late Oligocene *M. scabrosa* (Dall), described from the Tampa Limestone. In the Oligocene of the Old World the oldest known species is *Murex pereger* Beyrich, 1854. In the Miocene of France and Germany there is another species that has been cited as "*Murex cristatus* Brocchi" (*e.g.*, Hörnes, 1856, pl. 25, fig. 6) but which is not that species. True *Murex cristatus* Brocchi, 1814, is common in the Plio-Pleistocene of Italy and doubtless gave rise to the Recent *Murex blainvillei*, type of the genus. There is a question as to the specific distinctness of *M. cristatus* and *M. blainvillei*, as was discussed in a previous paper (Vokes and Houart, 1986, p. 85). On the whole, the fossil shells are larger (often 35-40 mm in height) and the Recent ones smaller (maximum height 25 mm). Comparison of other features, such as the protoconch, does not reveal any distinguishing characteristic and it was concluded that the two probably represent a single cline, which is changing though time. But given the fact the the name "*blainvillei*" is so entrenched in the literature, it would be unwise to synonymize the two names without better biological evidence than we presently have.

On the western coast of tropical America there are six species of *Muricopsis* living today. One of these, *M. armata* (A. Adams, 1854), is the Pacific cognate of the widespread Pliocene to Recent western Atlantic *M. oxytata*. Another, *M. jaliscoensis* Radwin and D'Attilio, 1970, is very like the Caribbean *M. huberti* Radwin and D'Attilio, 1976. The eastern Pacific species *M. pauxilla* (A. Adams, 1854) is most similar to *M. perexigua*, n. sp., described herein. The recently named eastern Pacific *M. skoglundae* Myers, Hertz, and D'Attilio, 1993, is remarkably similar to the also recently named Bahamian *M. zylmanae* Petuch, 1993. But the other two, *M. tulensis* Radwin and D'Attilio, 1976, and *M. zeteki* Hertlein and Strong, 1951, are unlike any known Atlantic form, the latter having columellar plications more akin to a species of

Vasum than to any known members of the Muricopsinae.

All of these Pacific species (except for *M. skoglundae*, which like its Atlantic cognate, is dredged from deeper water) are found intertidally under rocks, presumably having made the shift from a coralline habitat to a rocky one as changing environmental conditions demanded.

Muricopsis (Muricopsis) scabrosa (Dall)
Plate 1, figure 1

Tritonalia scabrosa DALL, 1915, U.S. Natl. Mus., Bull. 90, p. 77, pl. 5, fig. 15.
"Tritonalia" scabrosa Dall. MANSFIELD, 1937, Florida Geol. Surv., Bull. 15, p. 135.
[Muricopsis] scabrosa (Dall). VOKES, 1971, Bulls. Amer. Paleontology, v. 61, no. 268, p. 95.

Description: "Shell small, elevated, scabrous, of about 5 whorls beside the (decollate) nucleus; suture appressed, indistinct, flexuous; spire rather acute; axial sculpture of 7 rather stout rounded ribs extending from suture to canal, and of numerous more or less minutely scaly incremental lines covering the surface; spiral sculpture on the spire of 2 prominent duplex threads, slightly swollen where they cross the ribs and more or less minutely imbricate; on the body of the last whorl 5, and on the canal 3 similar spirals tending to become more or less spinose or bluntly pointed on the ribs at the shoulder; between these are numerous finer imbricate threads with wider interspaces; the whorl slopes to the shoulder from the suture; aperture with the outer lip thickened and crenulated by the spiral sculpture, internally with 5 short rather distant denticles; body and pillar with a thin wash of callus, the spiral sculpture on the canal under the enamel is preceptible; canal open, short, recurved." (Dall, 1915)

Holotype: USNM 166101; height 22.0 mm, diameter 12.0 mm.

Type locality: Tampa Limestone; Ballast Point, Tampa Bay, Hillsborough County, Florida.

Occurrence: Tampa Limestone, Florida.

Figured specimen: USNM 166101 (holotype).

Discussion: Muricopsis scabrosa is the earliest western Atlantic species referable to the genus *Muricopsis* s.s. It has the typical two columellar denticles, characteristic of most of the members of the genus *Muricopsis*. Presumably this is what Dall meant when he said: "The spiral sculpture on the canal under the enamel is perceptible."

The species is known only from the type locality and is rare there. Mansfield (1937, p. 135) did not make any comment upon the species but only quoted Dall's original reference. Dall (1915, p. 77) referred the form to the genus *Tritonalia* noting, "This might almost equally well be referred to *Muricidea* [i.e., *Muricopsis*], but it has the surface of *Tritonalia*." By this one can only assume he was referring to the axial growth lines, which give the shell its scabrous surface.

Muricopsis (Muricopsis) shirleyae
Vokes, n. sp.
Plate 1, figures 2, 3

Description: Shell biconic, seven teleoconch whorls in adult, plus protoconch of one and one-half smooth, bulbous whorls, ending at small recurved varix. Spiral ornamentation on first teleoconch whorl of one cord at mid-point and one at suture; that at shoulder initially weak but becoming stronger by second teleoconch whorl, and that at mid-point diminishing. Third and succeeding spire whorls marked by two major cords, one at shoulder and one at suture, with a secondary cord between them. On body whorl, in addition, two stronger cords near base of body whorl, each of the four alternating with a secondary cord. On siphonal canal one major cord near distal end, with three secondary cords between it and the major cord at base of body whorl. In some larger specimens tertiary threads developed between each of the primary and secondary cords, resulting in typical muricid pattern of first-, third-, second-, third-, first-order spiral ornamentation. Axial ornamentation on first teleoconch whorl of eight or nine small flanges with open loop at shoulder; on second or third whorl varices gradually becoming more complex, and developing a short sharp spine at shoulder. All later whorls with six or seven varices per whorl, composed of multiple layers of shelly material, with small sharp, open spines developed at intersection of spiral cords, size of spine proportional to size of cord; that at shoulder the largest. Varices approximately aligned with those of preceeding whorls, forming a more or less straight line up the spire. Suture extremely appressed. Aperture oval, posterior end extended into an adapically directed anal notch; inner lip smooth, appressed at posterior end, standing free along anterior portion. Some specimens with two faint denticles at anterior end of columellar lip, but lacking in most. Inner side of outer lip with six equisized denticles, located between major spiral cords. Siphonal canal short, recurved at distal end, succession of terminations giving rise to a small umbilicus.

Holotype: USNM 645621; height 14.6 mm, diameter 9.0 mm.

Type locality: TU 547, Chipola Formation; west bank of Chipola River, about 2000 ft. above Fourmile Creek (SW 1/4 Sec. 29, T1N, R9W), Calhoun County, Florida.

Etymology of name: In memory of the late Shirley E. Hoerle (Mrs. Robert C. Hoerle), West Palm Beach, Florida, excellent amateur paleontologist, dear friend, and collector of the holotype specimen.

Occurrence: Chipola Formation, Florida.

Figured specimens: Fig. 2, USNM 645621 (holotype). Fig. 3, USNM 482014 (paratype); height 7.3 mm, diameter 4.5 mm; locality TU 819. Additional localities: TU 555, 1048, 1196.

Discussion: This new species is similar to the younger Dominican species *M. praepauxilla* but differs in having a more compressed outline with four major spiral cords in contrast to the three of *M. praepauxilla* and, as a result, six apertural denticles in place of the five in *M. praepauxilla*. Neither has the "typical" *Muricopsis* columellar denticles but given the overall morphology of the shells there is no reason not to include them in this genus. The new species is most nearly akin to the Pliocene to Recent *M. oxytata*, especially the more squamose specimens, but differs in the more compressed outline.

All of the localities from which this new species has been taken are in the more coralline facies of the Chipola Formation, especially the two "coral-reef" localities on the Chipola River (TU 547, 555). The other localities are all on Farley Creek, also a more coralline facies. No specimens have been taken from the lime-mud facies on Tenmile Creek or the upper Chipola River.

MURICOPSIS (MURICOPSIS) species
Plate 1, figures 5, 6

Muricopsis species cf. *M. praepauxillus* (Maury). VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 68, pl. 8, figure 4 (said to be X 3 but is X 4).

Occurrence: Baitoa Formation, Dominican Republic. Chipola Formation, Florida.

Figured specimens: Fig. 5, USNM 482015; height 26.2 mm, diameter 13.2 mm; locality: TU 951. Fig. 6, NMB H 17186; height 15.0 mm, diameter 7.3 mm; locality: NMB 16943, Río Yaque del Norte just downstream from Boca de los Ríos, Dominican Republic. Additional locality: TU 830.

Discussion: In the Dominican report (Vokes, 1989, pl. 8, fig. 4) I figured a battered specimen from the Baitoa Forma-

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PLATE 1

Figures — Page

1. *Muricopsis (Muricopsis) scabrosa* (Dall) 53
(X 2 1/2) USNM 166101 (holotype); height 22.0 mm, diameter 12.0 mm.
Locality: Ballast Point, Tampa Bay, Florida. Tampa Limestone.

2, 3. *Muricopsis (Muricopsis) shirleyae* Vokes, n. sp 53
2. (X 4) USNM 645621 (holotype); height 14.6 mm, diameter 9.0 mm.
Locality: TU 547, Chipola River, Florida. Chipola Formation.
3. (X 8) USNM 482014 (paratype); height 7.3 mm, diameter 4.5 mm.
Locality: TU 819, Farley Creek, Florida. Chipola Formation.

4. *Muricopsis (Muricopsis) praepauxilla* (Maury) 56
(X 4) USNM 323896; height 13.2 mm, diameter 7.3 mm.
Locality: TU 1215, Río Gurabo, Dominican Republic. Gurabo Formation.

5, 6. *Muricopsis (Muricopsis)* species 53
5. (X 2) USNM 482015; height 26.2 mm, diameter 13.2 mm.
Locality: TU 951, Tenmile Creek, Florida. Chipola Formation.
6. (X 3) NMB H 17186; height 15.0 mm, diameter 7.3 mm.
Locality: NMB 16943, Río Yaque del Norte, Dominican Republic. Baitoa Formation.

7. *Muricopsis (Muricopsis) quisqueyensis* Vokes 56
(X 4) USNM 365148 (paratype B); height 13.2 mm, diameter 7.4 mm.
Locality: TU 1215, Río Gurabo, Dominican Republic. Gurabo Formation.

8. *Muricopsis (Muricopsis)* sp. cf. *quisqueynsis* Vokes 57
(X 4) USNM 482016; height (incomplete) 11.1 mm, diameter 7.0 mm.
Locality: TU 954. Pueblo Nuevo, Costa Rica. Moín Formation.

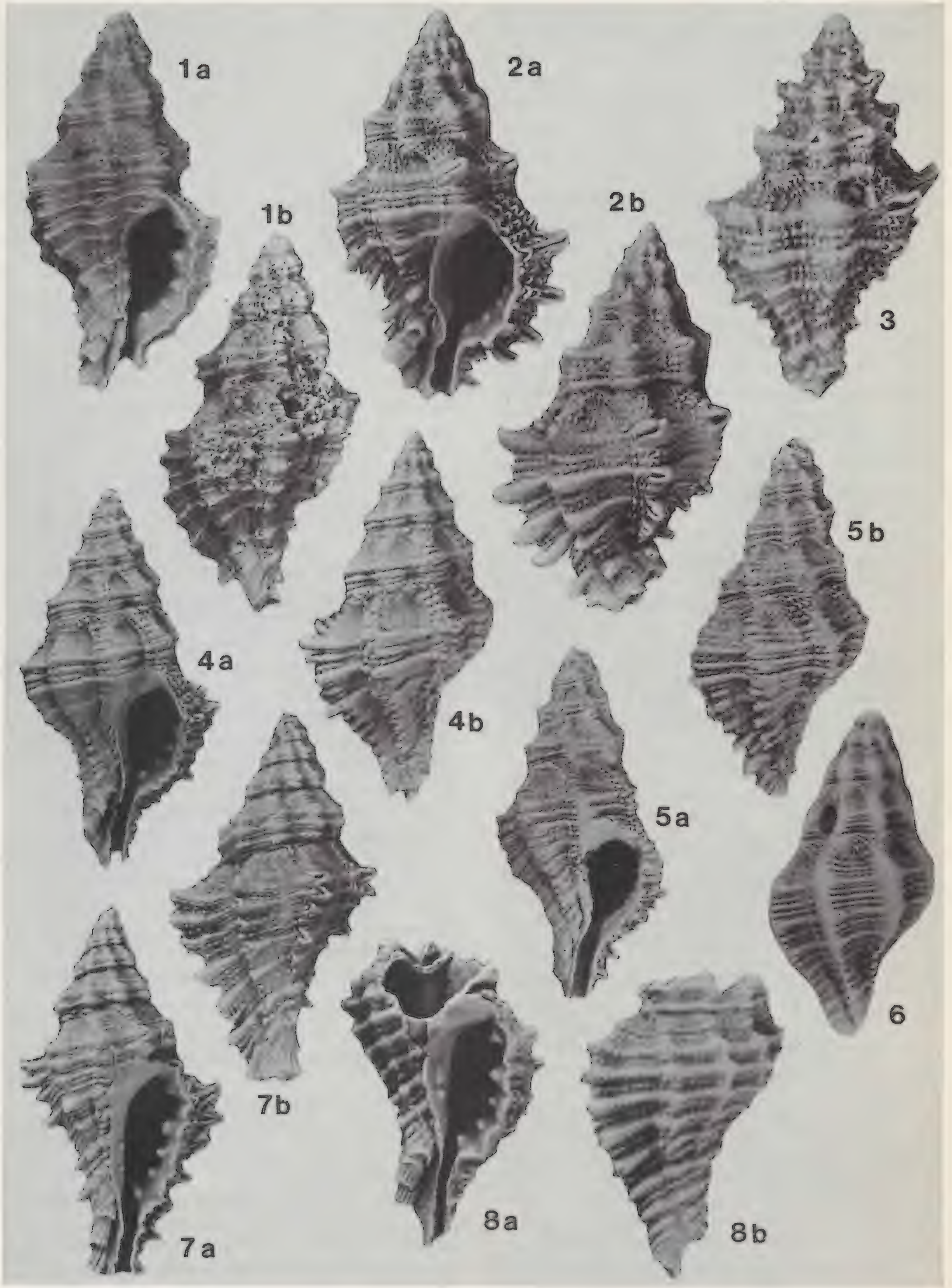

PLATE 1

tion, which I felt was not the same as the younger *M. praepauxilla,* but was too poorly preserved to be described. Since then we have collected one incomplete example from the Chipola Formation along Tenmile Creek (TU 830) and Gary W. Schmelz has collected another (pl. 1, fig. 5), only slightly better. Because the occurrence of these specimens is another indication of the correlation of the two formations, it was deemed desirable to call attention to the form even though the material is less than optimum.

Although of the same general shape as *M. praepauxilla,* these older shells are larger and have the major spiral cords less well developed but with stronger secondary spiral threads covering the entire shell surface, where *M. praepauxilla* is essentially bare. In the latter character this form is more similar to *M. oxytata;* however, it differs from both *M. oxytata* and *M. praepauxilla* in having eight denticles on the inner side of the outer lip. Presumably it is a new species but the present material is too poor to describe at this time.

In contrast to *M. shirleyae,* which is confined to the coralline portions of the Chipola Formation, the only two Florida examples of this form come from the lime-mud of the basal Chipola Formation on Tenmile Creek.

Muricopsis (Muricopsis) praepauxilla (Maury)
Plate 1, figure 4

Murex (Phyllonotus) praepauxillus MAURY, 1917, Bulls. Amer. Paleontology, v. 5, no. 29, p. 103(276), pl. 16(42), fig. 11; VAUGHAN and WOODRING *in* VAUGHAN *et al.*, 1921, Geol. Surv. Dom. Rep., Mem., v. 1, p. 141.

Not *Muricopsis praepauxillus* (Maury). VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 214; DE JONG and COOMANS, 1988, Stud. Fauna Curaçao, Caribbean Islands, v. 49, p. 74, pl. 37, fig. 402 [= *M. warreni* Petuch].

Muricopsis praepauxillus (Maury). VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 67, pl. 8, figs. 2 (holotype), 3.

Not *Muricopsis praepauxilla* (Maury). SUNDERLAND and SUNDERLAND, 1993, Amer. Conchologist, v. 21, no. 4, p. 15, text-fig. [= *M. huberti* Radwin and D'Attilio].

Description: "Shell with seven whorls, the first two [one and one-half] smooth, nuclear, later whorls with low crenate varices, six [five to seven] to a whorl, and three main, crenate ridges revolving around the periphery. The uppermost spiral of each trio carinates the whorl, and on crossing the varices forms short, hollow spines; aperture narrowly elliptical; canal open, somewhat reflexed; outer lip edged by the final fimbriated varix and bearing within five well-marked denticles." (Maury, 1917)

Holotype: PRI 28755; height 12.5 mm [not 16 mm as stated by Maury], diameter 7.2 mm.

Type locality: Zone D, Gurabo Formation; Río Gurabo, Dominican Republic (= TU 1215).

Occurrence: Cercado and Gurabo formations, Dominican Republic.

Figured specimen: USNM 323896; height 13.2 mm, diameter 7.3 mm; locality TU 1215. Additional localities: TU 1227A, 1422.

Discussion: Maury (1917, p. 103) named this Dominican species "*praepauxillus*" in the belief that it was most closely related to the living eastern Pacific species *Murex pauxillus* A. Adams, 1854. However, the resemblance is only generic. The most closely related species is that one recently named *M. warreni* Petuch, 1993, which was originally figured by Humfrey (1975, pl. 16, fig. 1) as *Muricopsis* sp. from Jamaica. Both of these species differ from the typical form in having a more pronounced constriction where the body whorl meets the siphonal canal, resembling species of *Murexsul.* Nevertheless, the surface ornamentation and the apertural denticles indicate that they are to be referred to the group of *Muricopsis* s.s.

Muricopsis warreni is confined to a relatively shallow (4.5 to 12 meters) coralline environment, as was *M. praepauxilla,* which has only been taken at a few "coral-reef" localities in the Dominican Republic. However, the species is not rare there; we have over 70 specimens from the type locality on the Río Gurabo (Maury's Zone D = TU 1215).

Muricopsis (Muricopsis) quisqueyensis Vokes
Plate 1, figure 7

Muricopsis quisqueyensis VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 68, pl. 8, figs. 7-9.

Description: "Shell with six teleoconch whorls and a protoconch of one-and-one-half rounded whorls, ending in a small, sharp varix. Spiral ornamentation beginning with two strong cords, numerous smaller threads gradually added, covering the entire surface of the shell including

the major cords; the latter persisting to the body whorl, where a total of five major cords are developed, plus another two on the siphonal canal. Axial ornamentation beginning on first teleoconch whorl with seven or eight small varices, increasing to eight or nine on the adult whorls. Where spiral ornamentation crosses varices, short, sharp spines produced, their size relative to the size of the spiral cord; in addition, shell surface shagreened by the intersection of numerous axial growth lines and spiral threads. Aperture elongate-oval, inner lip appressed at posterior end and slightly free-standing at anterior end, two small denticles on anterior half. Inside of outer lip with five strong denticles, corresponding to spaces between the spiral cords; that one just anterior to shoulder cord much the largest. Siphonal canal short, broad." (Vokes, 1989)

Holotype: USNM 365146; height 14.5 mm, diameter 7.0 mm.

Type locality: TU 1215, Gurabo Formation; Río Gurabo, bluffs on both sides from the ford on the Los Quemados-Sabaneta road, upstream to approximately 1 km above the ford, Dominican Republic.

Occurrence: Gurabo Formation, Dominican Republic.

Figured specimen: USNM 365148 (paratype B); height 13.2 mm, diameter 7.4 mm; locality TU 1215. Additional localities: TU 1227A, 1250.

Discussion: Occurring with *M. praepauxilla* are specimens of another species of *Muricopsis, M. quisqueyensis*. This second species in many ways is more similar to the West American *M. pauxilla* than its namesake. From the more abundant *M. praepauxilla,* it differs in having a more biconic outline, with the siphonal canal less well demarcated from the body whorl. It also has five major spiral cords on the body whorl in contrast to the three of *M. praepauxilla*.

Muricopsis (Muricopsis) sp. cf. M. quisqueyensis Vokes
Plate 1, figure 8

Occurrence: Agueguexquite Formation, Mexico; Moín Formation, Costa Rica.

Figured specimen: USNM 482016; height (incomplete) 11.1 mm, diameter 7.0 mm; locality: TU 954. Additional locality: TU 638.

Discussion: In the Tulane Collections from the Agueguexquite Formation, Veracruz, Mexico, and the Moín Formation, Costa Rica, there are two incomplete specimens of a species that is most nearly like the Dominican *M. quisqueyensis,* but differs in having stronger spiral cords. Because both specimens are lacking the early whorls, it will not be described herein.

Muricopsis (Muricopsis) oxytata (Smith)
Plate 2, figures 1-6
Plate 3, figures 1-5
Plate 4, figure 4

Murex hexagonus LAMARCK, 1816, Tableau Encycl. Méth. (Vers), v. 3, pl. 418, fig. 3; Le Liste, p. 5 ; LAMARCK, 1822, Anim. sans Vert., v. 7, p. 169; KIENER, 1842, Coq. Viv., v. 7, *Murex*, p. 96, pl. 8, fig. 3; REEVE, 1845, Conch. Icon., v. 3, *Murex*, pl. 27, fig. 120; SOWERBY, 1879, Thes. Conch., v. 4, *Murex*, pl. 24, fig. 257 (*non Murex hexagonus* Gmelin, 1791).

Murex hexagonus oxytata M. SMITH, 1938, Nautilus, v. 51, no. 3, p. 89, pl. 6, fig. 6.

Muricidea hexagonus (Lamarck). M. SMITH, 1939, Illus. Cat. Recent Species Rock Shells, p. 11, pl. 6, fig. 3 (SMITH, 1953, *ibid.*)

Muricopsis hexagonus (Lamarck). OLSSON and HARBISON, 1953, Acad. Nat. Sci. Phila., Mon. 8, p. 247, pl. 37, fig. 4 (including *M. hexagonus oxytata* in synonymy); ABBOTT, 1954, Amer. Seashells, p. 209, pl. 25h.

Muricopsis oxytata/oxytatus (Smith). ABBOTT, 1958, Acad. Nat. Sci. Phila., Mon. 11, p. 63; OLSSON and MCGINTY, 1958, Bulls. Amer. Paleontology, v. 39, no. 177, p. 15; WARMKE and ABBOTT, 1961, Caribbean Sea Shells, p. 106, pl. 19e; ABBOTT, 1974, Amer. Seashells (ed. 2), p. 197, fig. 1957; HUMFREY, 1975, Sea Shells of the West Indies, p. 137, pl. 16, fig. 2; FAIR, 1976, The Murex Book, p. 64, pl. 17, fig. 226; RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 169, pl. 27, fig. 5; KAICHER, 1980, Card Catalogue World-wide Shells, pack 25, Muricidae – Part V, no. 2552; ABBOTT and DANCE, 1982, Compendium Seashells, p. 144, color fig.; VOKES and VOKES, 1983, Mesoamer. Ecol. Inst., Mon. 1 (MARI Publ. 54), p. 24, pl. 12, fig. 14; VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 214, back cover color photo; VOKES, 1988, Tulane Stud. Geol. Paleont., v. 21, no. 1, p. 34, pl. 4, figs. 9, 10; DE JONG and COOMANS, 1988, Stud. Fauna Curaçao, Caribbean Islands, v. 49, p. 74; SUNDERLAND and SUNDERLAND, 1993, Amer. Conchologist, v. 21, no. 4, p. 15, text-fig.

Muricopsis lyonsi PETUCH, 1986, Jour. Coastal Resh., v. 2, no. 4, p. 404, pl. 4, figs. 12, 13; PETUCH, 1988, Neogene Hist. Trop. Amer. Moll., pl. 17, fig. 11 (holotype).

Description: "Sculpture fine, spiny processes sharp; shell inclined to be rather slender when compared with West Indian recent examples

which are more rudely sculptured. The new subspecies appear [*sic*] to agree with living specimens from the Florida east coast and which may also bear the same name." (Smith, 1938)

Holotype: Said by Smith to be in Museum of Comparative Zoology, but not found (Fred Collier, 1993, personal communication); height 22 mm (*fide* Smith, 1938).

Type locality: Caloosahatchee Formation; Clewiston, Hendry County, Florida.

Occurrence: Esmeraldas Beds, Ecuador; Pinecrest Beds [= Fruitville Formation], Tamiami, Caloosahatchee, and Bermont formations, Florida; Tubará Group, Colombia; Moín Formation, Costa Rica; Recent, western Atlantic, Florida to Veracruz, Mexico, Panama and Costa Rica, northern South American.

Figured specimens: PLATE 2. Fig. 1, USNM 645623; height 35.0 mm, diameter 17.5 mm; locality TU 797. Fig. 2, USNM 482017, height 30.0 mm, diameter 13.5 mm; locality TU 541. Fig. 3, USNM 418051; height 19.3 mm, diameter 9.0 mm; locality TU 726. Fig. 4, USNM 482018; height 23.3 mm, diameter 12.7 mm; locality TU 1240. Fig. 5, USNM 482019; height 18.0 mm, diameter 10.1 mm; locality TU 1240. Fig. 6, USNM 880000; height 18.3 mm, diameter 12.6 mm; locality, off Portobelo, Panama. PLATE 3. Fig. 1, USNM 880001; height 27.5 mm, diameter 15.5 mm; locality, off Palm Beach, Florida, 30 meters. Fig. 2, USNM 880002; height 11.6 mm, diameter 7.5 mm; locality, off Palm Beach, Florida, 30 meters. Fig. 3, USNM 880003; height 36.6 mm, diameter 20.0 mm (including spines); locality, off Dania, Florida, 21 meters. Fig. 4, USNM 880004; height 26.0 mm, diameter 15.7 mm; locality, Caribe Point, Roatan, Bay Islands, Honduras, 1 meter. Fig. 5, USNM 880005; height 11.5 mm, diameter 7.5 mm; locality, Caribe Point, Roatan, Bay Islands, Honduras, 1 meter. PLATE 4. Fig. 4, USNM 880006; height 36.1 mm, diameter 22.8 mm (including spines); locality, Lago Enriquillo, Dominican Republic, Holocene. Additional localities: TU 202, 203, 523, 527, 529B, 536, 767, 933, 954, 978, 988, 991, 1000, 1175, 1239, 1307, 1490, 1493.

Discussion: The name *Murex hexagonus* Lamarck is preoccupied by that of Gmelin, 1791, and the next available name is *M. oxytata* Smith, 1938. Although named as a subspecies, the distinction is not valid (Abbott, 1958, p 63).

As was discussed earlier (Vokes, 1988, p. 34), although some authors have spelled the name "*oxytatus*" in agreement with the (presumable masculine) genus *Muricopsis*, the name "*oxytata*" is a noun, meaning "spiny daddy," presumably a reflection of Smith's belief that this form was ancestral to the living *M. hexagona*.

The species is widespread in the Plio-Pleistocene of southern Florida. It also occurs in the Moín Formation of Costa Rica and the Tubará Group of northern Colombia, both of Pleistocene age. In addition to these western Atlantic occurrences, it has been collected in the Pliocene Esmeraldas beds of northwestern Ecuador (Vokes, 1988, pl. 4, fig. 9), one of the few species in common between the western Atlantic and eastern Pacific muricid faunas.

Although most specimens of *M. oxytata* are relatively smooth between the major spiral cords (pl. 2, figs. 1, 6; pl. 3, figs. 1-5), this is not always the case. Some specimens are extremely squamose (pl. 2, figs. 2-5). Some have high spires (pl. 2, figs. 1-3), others have low spires (pl. 2, fig. 6; pl. 3, figs. 1, 4). Some have short or no spines (pl.

PLATE 2

Figures Page

1-6. *Muricopsis (Muricopsis) oxytata* (M. Smith) 57

1. (X 2) USNM 645623; height 36.0 mm, diameter 17.5 mm.
   Locality: TU 797, "Alligator Alley," Florida. Tamiami Formation.
2. (X 2) USNM 482017, height 30.0 mm, diameter 13.5 mm.
   Locality: TU 541, Miami Canal, Florida (?)Caloosahatchee Formation.
3. (X 3) USNM 418051; height 19.3 mm, diameter 9.0 mm.
   Locality: TU 726, Caloosahatchee River, Florida. Caloosahatchee Formation.
4. (X 2) USNM 482018; height 23.3 mm, diameter 12.7 mm.
   Locality: TU 1240, Los Corales, Costa Rica. Moín Formation.
5. (X 3) USNM 482019; height 18.0 mm, diameter 10.1 mm.
   Locality: TU 1240, Los Corales, Costa Rica. Moín Formation.
6. (X 3) USNM 880000; height 18.3 mm, diameter 12.6 mm.
   Locality: off Portobelo, Panama. Recent.

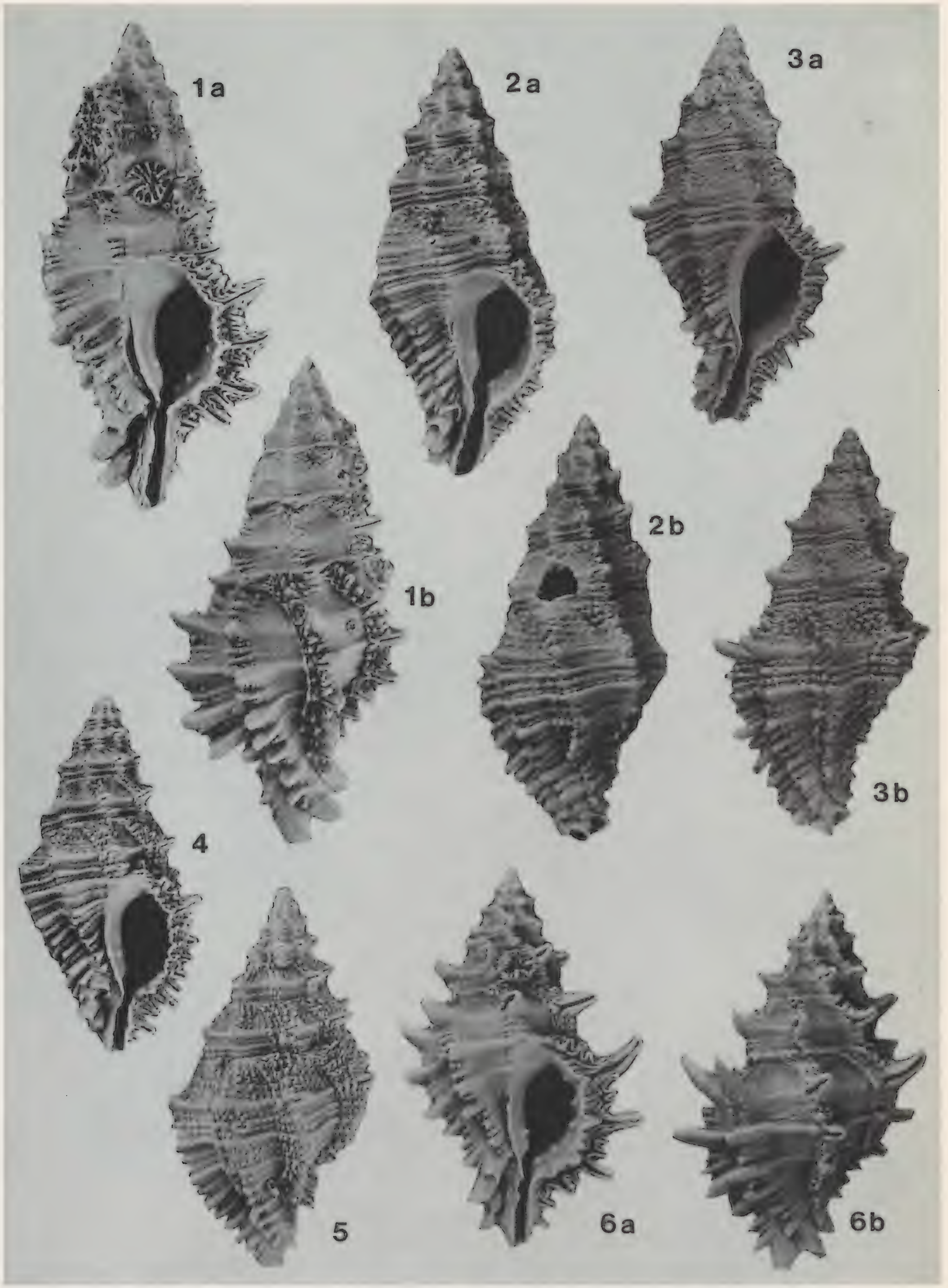

PLATE 2

2, figs. 2-5) and others, like the original illustration, have long spines (pl. 4, fig. 4). These variations are presumably a result of varying ecologic conditions.

Petuch has described *Muricopsis lyonsi* (1986, p. 404, pl. 4, figs. 12, 13) from the Pliocene of southeastern Florida, which he stated differs from *M. oxytata* in lacking the varical spines. In the Tulane Collections we have a number of these short-spined forms (pl. 2, fig. 2) from several different localities, including the type locality (= TU 1493) and they would appear to be simply ecologic variants.

If, indeed, the length of spines is a specific character, then the name *M. oxytata* must be applied to the short-spined form (pl. 2, fig. 3 is a typical Caloosahatchee Formation specimen of *M. oxytata*) and the long-spined Recent specimens are without a name.

The morphology of *M. oxytata* is intermediate between true *Muricopsis,* as typified by the Mediterranean species *M. blainvillei* (Payraudeau) and the genus *Murexsul.* For example, most specimens of *M. oxytata* do not have columellar denticles, but some do (see pl. 2, figs. 2, 4, 6; pl. 3, fig. 1). Ponder (1972, p. 238) has proposed that *Muricopsis* and *Murexsul* should be synonymized because the differences between the two forms are not sufficient to distinguish them. Species such as *M. oxytata* tend to reinforce such a proposal, and yet, most species are readily distinguishable. As the two lines have a long geologic history of separation, it is concluded that the modern resemblances are a result of convergence.

MURICOPSIS (MURICOPSIS) HUBERTI
Radwin and D'Attilio
Plate 5, figures 1-4

[?] *Muricopsis oxytatus* (Smith). WORK, 1969, Bull. Mar. Sci., v. 19, no. 3, p. 667 (?*not* of Smith).

Muricopsis huberti RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 232, text-figs. 182 (shell), 183 (radula); VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 214; DE JONG and COOMANS, 1988, Stud. Fauna Curaçao, Caribbean Islands, v. 49, p. 74, pl. 37, fig. 403; VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 68; SUNDERLAND and SUNDERLAND, 1993, Amer. Conchologist, v. 21, no. 4, p. 15, text-fig.

Muricopsis duffyi PETUCH, 1992, La Conchiglia, Ann. 23, no. 262, p. 5, fig. 2.

Muricopsis praepauxilla (Maury). SUNDERLAND and SUNDERLAND, 1993, Amer. Conchologist, v. 21, no. 4, p. 15, text-fig. (*not* of Maury).

Description: "The shell is small for the genus (maximum length 14.8 mm*) and stroutly fusiform. The spire is high and acute, consisting of five weakly shouldered postnuclear whorls and a protoconch of undetermined nature [one and one-half rounded whorls]. The suture is distinct where the shell is not eroded. The body whorl is comparatively short and broadly fusoid. The aperture is moderately small and ovate, with a narrow, shallow anal sulcus. The outer apertural lip is briefly erect and finely serrate, reflecting the outer shell sculpture; its inner surface bears five equal-sized moderately prominent denticles, the posteriormost slightly set off from the others. The columellar lip is adherent,

*This is obviously an error, for paratypes in the Academy of Natural Sciences of Philadelphia (ANSP 332226) measure 19.5 mm and 18.5 mm in length [= height].

PLATE 3

Figures Page

1-5. *Muricopsis (Muricopsis) oxytata* (M. Smith) 57

1. (X 2) USNM 880001; height 27.5 mm, diameter 15.5 mm.
   Locality: off Palm Beach, Florida. Recent.
2. (X 4; protoconch X 10) USNM 880002; height 11.6 mm, diameter 7.5 mm.
   Locality: off Palm Beach, Florida. Recent.
3. (X 2) USNM 880003; height 36.6 mm, diameter 20.0 mm (including spines).
   Locality: off Dania, Florida. Recent.
4. (X 2) USNM 880004; height 26.0 mm, diameter 15.7 mm.
   Locality: Roatan, Bay Islands, Honduras. Recent.
5. (X 4; protoconch X 10) USNM 880005; height 11.5 mm, diameter 7.5 mm.
   Locality: Roatan, Bay Islands, Honduras. Recent.

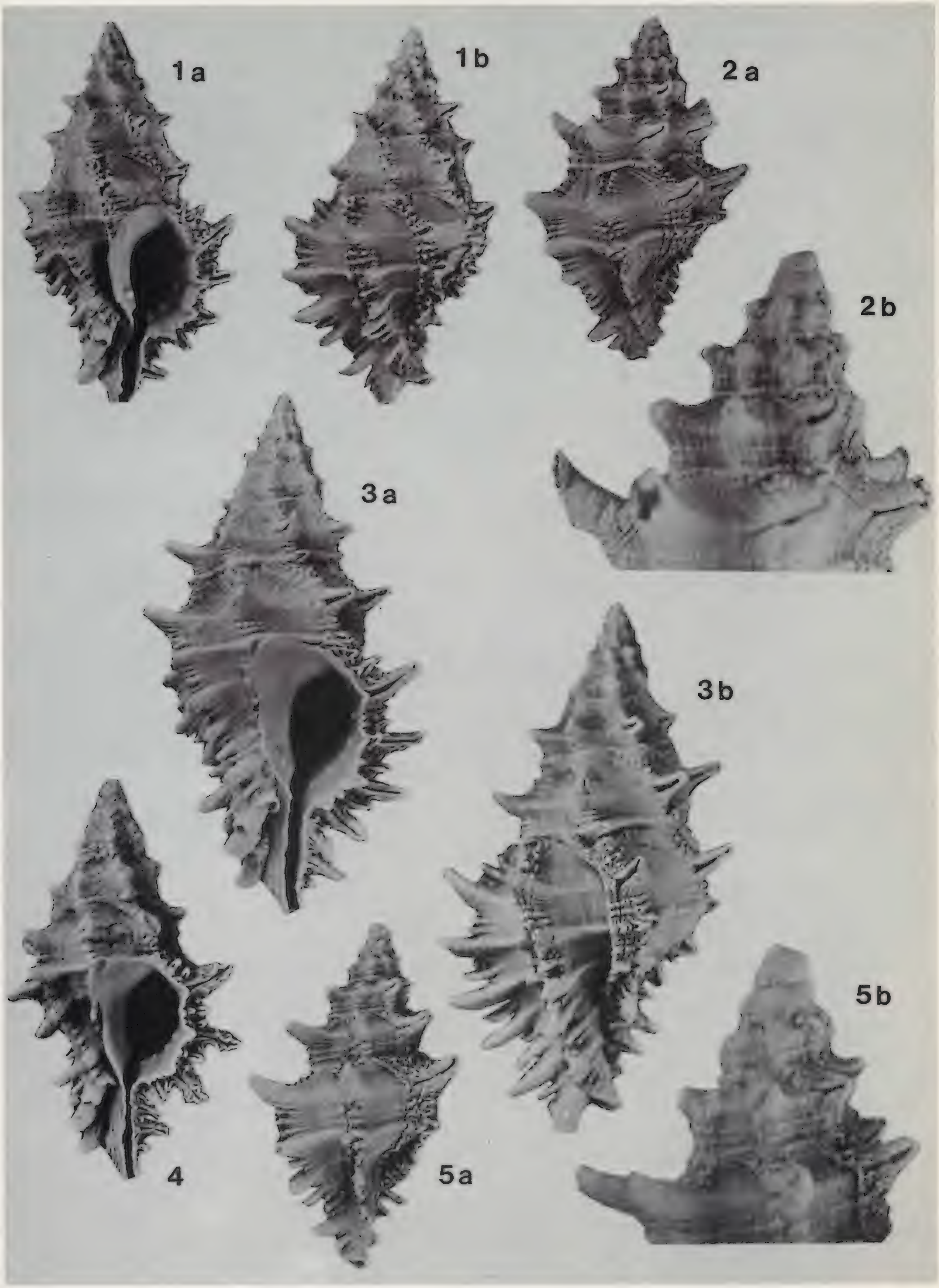

PLATE 3

except at its extreme anterior end, where it bears two low, small oblique pustules. The siphonal canal is very broad and short, and tends to be more or less bent to the left.

"The body whorl bears five or six low, sharp-crested varices, these aligned obliquely up the spire. All but the last-formed varix are comparatively featureless, and the last one or two are developed into weak flanges with three or four very short, sharp spines at the margin. Spiral sculpture consists of five major cords; a slightly weaker one on the shoulder, three on the body, and one on the canal. In addition there are one or two minor threads between each two major cords. The varices are very broad-based, the intervarical spaces very narrow.

"Shell color is white. The aperture is porcelaneous white." (Radwin and D'Attilio, 1976)

Holotype: SDMNH 63078; height 14.2 mm, diameter 7.4 mm.

Type locality: West side of Grenada, West Indies, 4.5 meters.

Occurrence: Recent only, Lesser Antilles to Curaçao (de Jong and Coomans, 1988, p. 74) and Panama (Sunderland and Sunderland, 1993, p. 15).

Figured specimens: Fig. 1, USNM 880007; height 18.6 mm, diameter 10.5 mm; locality, Antigua, British West Indies, 5 meters. Fig. 2, Vink Collection; height 13.2 mm, diameter 6.4 mm; locality, Curaçao, Netherlands Antilles, 0.5 meter. Fig. 3, USNM 880008; height 20.0 mm, diameter 11.1 mm; locality, Los Roques Archipelago, Venezuela, 2-3 meters. Fig. 4, CMNH 47340 (holotype – *Muricopsis duffyi* Petuch); height 21.4 mm, diameter 11.2 mm; locality, Noronqui [?Moronqui], Los Roques Archipelago, Venezuela, 2 meters.

Discussion: Most specimens of this species are badly lime-encrusted, but a juvenile in the collection of Danker Vink (pl. 5, fig. 2) shows the species to have typical *Muricopsis* surface ornamentation, with three major spiral cords (see Sunderland and Sunderland, 1993, p. 15, text-fig.). The overall shape is relatively low-spired compared to other members of the genus. Although compared by the original authors to the Dominican *M. praepauxilla,* the form differs in the shorter siphonal canal and more expanded body whorl. The protoconch, although similar, is larger in *M. huberti* than in *M. praepauxilla* (0.8 mm in diameter *vs.* 0.6 mm in the fossil species).

Petuch (1992, p. 5) recently has named *M. duffyi,* which he stated is most similar to *M. huberti,* differing in having a more elongated shell with a wider and more sloping subsutural area. Comparison of material of both "species" fails to disclose any noticable difference in the two forms. Most specimens are heavily encrusted with lime (pl. 5, fig. 4), indicating a particular environmental situation.

Work (1969, p. 667) reported specimens of "*M. oxytatus*" from the Los Roques Islands, Venezuela. I have not seen his material, but given the locality it is possible that what he had was *M. huberti.* I have not seen any specimens of *M. oxytata* from Los Roques; however, de Jong and Coomans (1988, p. 74) report "*M. oxytatus*" as "rather common" in the Netherlands

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PLATE 4

Figures Page

1-3. *Muricopsis (Muricopsis) zylmanae* Petuch 66
1. (X 2) CMNH 47379 (holotype); height 32.0 mm, diameter 18.5 mm (including spines).
Locality: Great Isaacs Cay, Bahama Islands. Recent.
2. (X 1 1/2) Sunderland Collection (paratype); height 46.1 mm; diameter 34.0 mm (including spines).
Locality: Cay Sal Bank, Bahama Islands, Recent.
3. (X 2) Stephens Collection; height 26.7 mm, diameter 17.2 mm (including spines).
Locality: Cay Sal Bank, Bahama Islands. Recent.
4. *Muricopsis (Muricopsis) oxytata* (Smith) 57
(X 1 1/2) USNM 880006; height 36.1 mm, diameter 22.8 mm (including spines).
Locality: Lago Enriquillo, Dominican Republic. Holocene.
5, 6. *Muricopsis (Muricopsis) perexigua* Vokes, n. sp 68
5. (X 8) ANSP 374072 (holotype); height 6.2 mm, diameter 3.7 mm.
Locality: Grand Bahama Island, Bahama Islands. Recent.
6. (X 8) ANSP 397690 (paratype); height 5.8 mm, diameter 3.3 mm.
Locality: same as holotype.

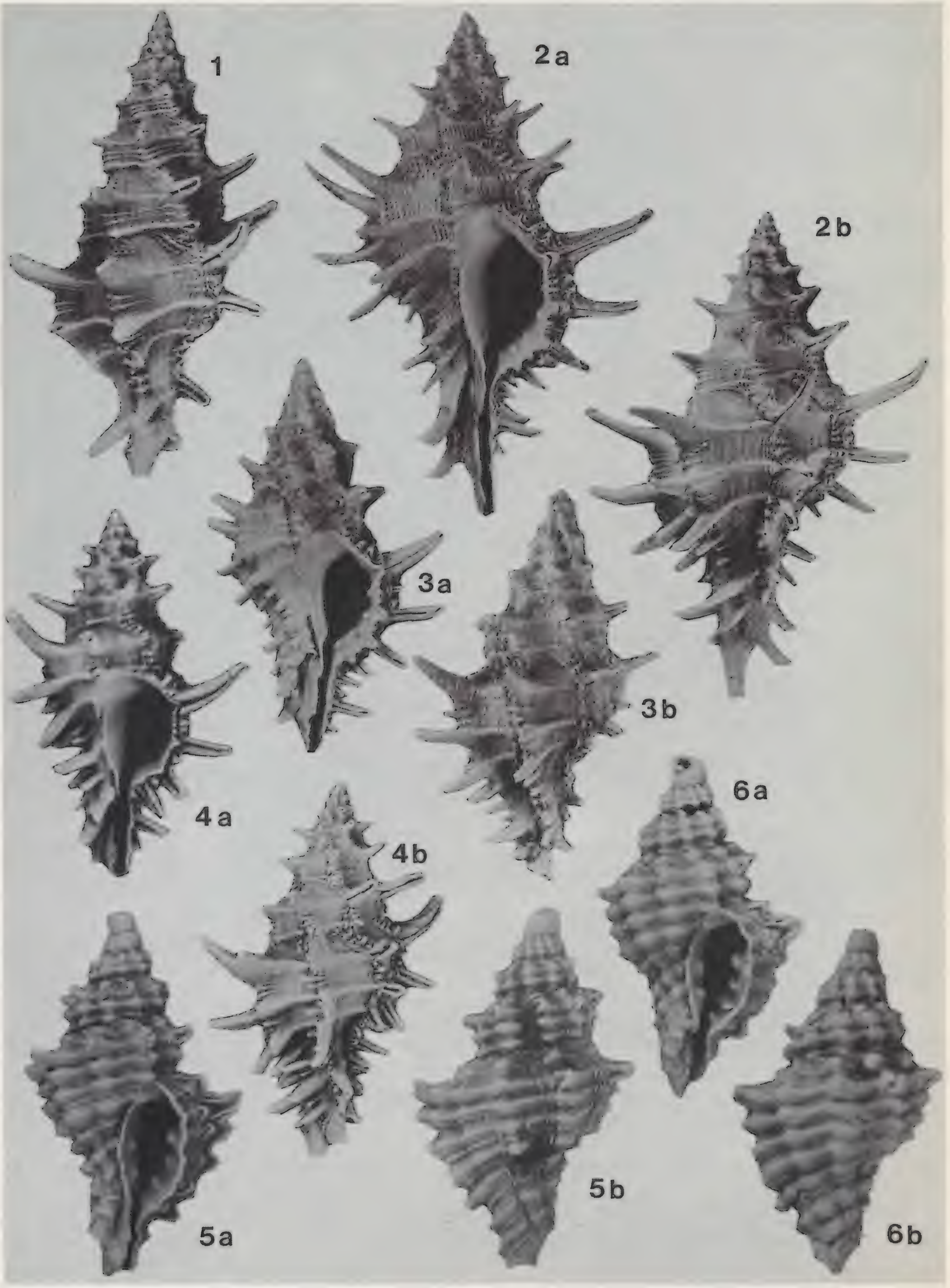

PLATE 4

Antilles. As they also figure a typical specimen of *M. huberti* (1988, p. 74, pl. 37, fig. 403), which, as they note, "looks as being covered with chalk," it is assumed that *M. oxytata* is correctly identified, even though unfigured.

Muricopsis (Muricopsis) warreni
Petuch
Plate 5, figure 5

Muricopsis sp. HUMFREY, 1975, Sea Shells of the West Indies, p. 137, pl. 16, fig. 1.

Muricopsis praepauxillus (Maury). VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 214; DE JONG and COOMANS, 1988, Stud. Fauna Curaçao, Caribbean Islands, v. 49, p. 74, pl. 37, fig. 402 (*not* of Maury).

Muricopsis warreni PETUCH, 1993, La Conchiglia, Ann. 25, no. 266, p. 55, figs. 8, 9; SUNDERLAND and SUNDERLAND, 1993, Amer. Conchologist, v. 21, no. 4, p. 14, text-fig. (paratype)

Description: "Shell small for genus, biconic, with sharply-angled shoulder; whorls with 6 thin, bladelike varices; intervarical areas smooth, waxy; each varix of body whorl with 3 large, prominent spiral cords that circumscribe entire body whorl; smaller secondary spines sometimes present between large primary varical spines; siphonal varices with one large spine and numerous tiny secondary spines; aperture proportionally large; inner edge of lip with 5 large toothlike denticles; shell color bright rosy-pink with 3 revolving white bands, corresponding to large spiral cords; dark brown bands present between large white cords, producing central area of alternating brown and white bands; brown band along shoulder detached at each varix, producing large dark brown patch at each shoulder spine and at each spire spine; siphonal canal bright pink, with one third brown band; aperture and parietal area intense rosy-pink." (Petuch, 1993)

Holotype: CMNH 47381; height 16.6 mm, diameter 9.5 mm.

Type locality: Montego Bay, Jamaica, 20 meters.

Occurrence: Recent only, Jamaica to Curaçao (de Jong and Coomans, 1988, p. 74) and Grenada (Sunderland Collection).

Figured specimen: USNM 880009; height 14.5 mm, diameter 8.0 mm; locality, west of Montego Bay, north coast of Jamaica, 24 meters.

Discussion: As discused previously (Vokes, 1989, p. 68), it is this species, originally figured by Humfrey (1975, pl. 16, fig. 1) from Ocho Rios, Jamaica, that is the modern analog of the Dominican *M. praepauxilla*. The living species is always associated with coral reefs and is invariably encrusted with a heavy coating of lime, making the details of sculpture hard to see. It is readily distinguished from all other species of *Muricopsis* by its distinctive black and white striped shell, with a striking pink aperture (pl. 5, fig. 5a, shows the color pattern of the stripes but unfortunately not the lovely pink aperture).

De Jong and Coomans (1988, p. 74, pl. 37, fig. 402) have illustrated as *M. praepauxilla* one of two specimens they have from Curaçao that appear to be the same as the Jamaican species. In particular, the authors note that the outside of the shell is white "except for brown spots on the last quarter of the main whorl between the spiral ridges and the varices." The only species that has these brown spots is *M. war-*

PLATE 5

Figures Page

1-4. *Muricopsis (Muricopsis) huberti* Radwin and D'Atttilio 60
1. (X 3) USNM 880007; height 18.6 mm, diameter 10.5 mm.
Locality: Antigua, British West Indies. Recent.
2. (X 4; protoconch X 10) Vink Collection; height 13.2 mm, diameter 6.4 mm.
Locality: Curaçao, Netherlands Antilles. Recent.
3. (X 3) USNM 880008; height 20.0 mm, diameter 11.1 mm.
Locality: Los Roques Archipelago, Venezuela. Recent.
4. (X 3) CMNH 47340 (holotype – *Muricopsis duffyi* Petuch); height 21.4 mm, diameter 11.2 mm.
Locality: Los Roques Archipelago, Venezuela. Recent.
5. *Muricopsis (Muricopsis) warreni* Petuch 64
(X 4) USNM 880009; height 14.5 mm, diameter 8.0 mm (fig. 5a not whitened, to show color pattern).
Locality: west of Montego Bay, Jamaica. Recent.

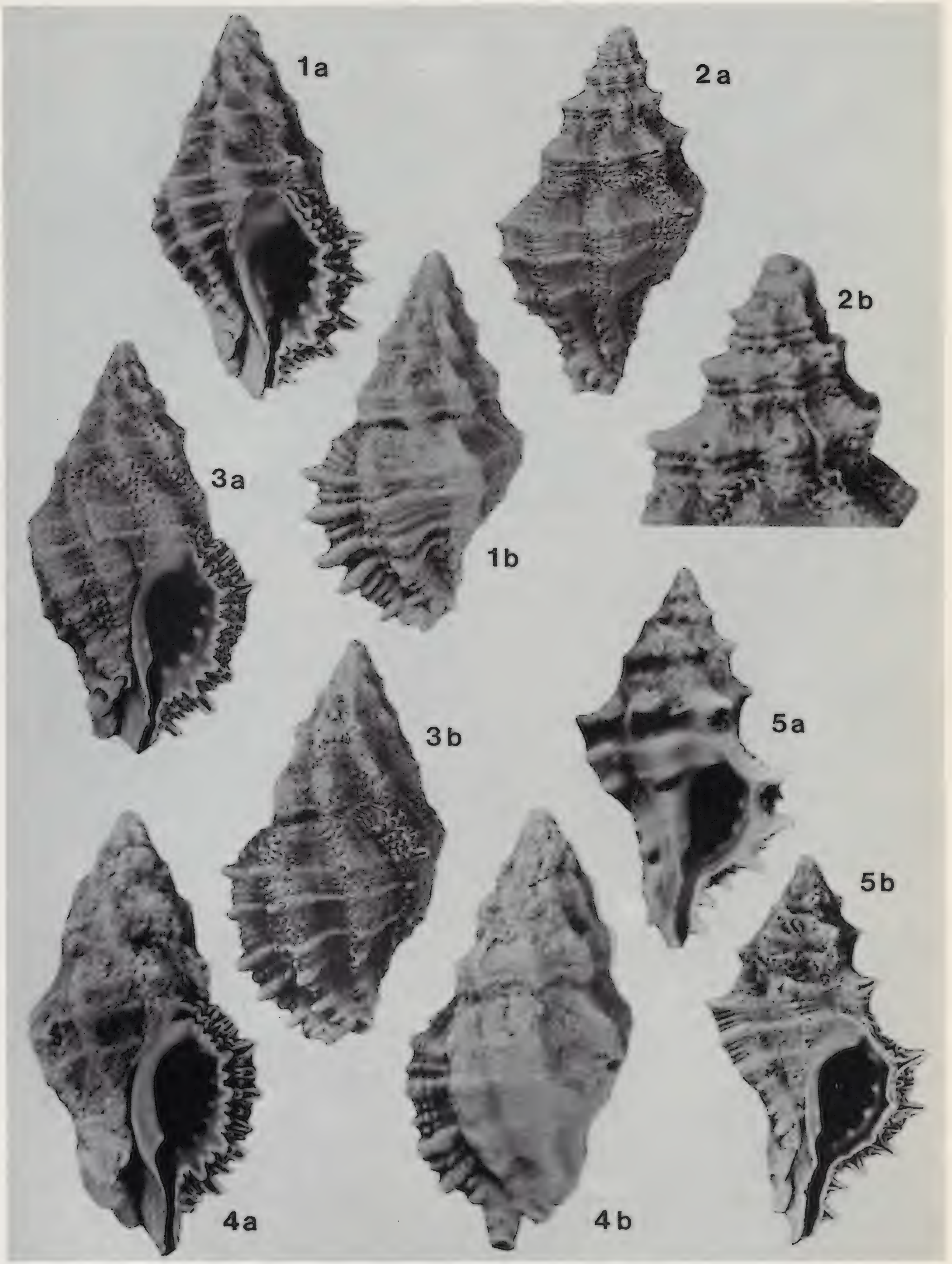

PLATE 5

reni; however, they also note that the aperture of these specimens is "porcelaneous white." In the collection of Kevan and Linda Sunderland, Sunrise, Florida, there is a similar appearing specimen from Ft. Jeudy, Grenada, taken in 1 meter, which also has a white aperture but is unquestionably *M. warreni*. Perhaps the pink-apertured shells are a local ecophentotypic variant in Jamaica.

MURICOPSIS (MURICOPSIS) SUNDERLANDI
Petuch
Plate 6, figures 1, 2

Muricopsis sunderlandi PETUCH, 1987, New Caribbean Moll. Faunas, p. 53, pl. 9, figs. 3-5; SUNDERLAND, 1987, Amer. Conchologist, v. 15, no. 4, p. 3 (plus color painting on cover by John Timmerman); KAICHER, 1991, Card Catalogue World-wide Shells, pack 59, Muricidae – Part VI, no. 6065 (holotype); SUNDERLAND and SUNDERLAND, 1993, Amer. Conchologist, v. 21, no. 4, p. 14, text-fig. (paratype).

Description: "Shell stocky, inflated, with spire lower than average for the genus, shell with 6 varices per whorl; varices extremely ornate, with body whorl varices having 4 long, tubular spines per varix; 1 or 2 small scale-like projections between 4 large spines; varices on siphonal canal with 2 large spines and several small spines in between; spire whorl varices with 1 large spine and 3 small spines per varix; shell color bright red-orange with single thin, white band around mid-body; siphonal canal white; intervarical areas smooth, with 4 large cords; mid-body cord corresponds to white band; columella white; interior of aperture red-orange." (Petuch, 1987)

Holotype: USNM 859848; height 12.6 mm, diameter 8.8 mm.

Type locality: Cay Sal Bank, Bahama Islands, 10 meters.

Occurrence: Recent only, Bahama Islands.

Figured specimens: Fig. 1, USNM 859848 (holotype). Fig. 2, USNM 880010; height 22.7 mm, diameter 15.1 mm (including spines); locality, R/V *Silver Bay* Station 3495, south of Long Island, Bahama Islands, 100-200 fathoms [183-366 meters].

Discussion: Sunderland (1987, p. 3) reported finding this species in water depths of 18 meters to as much as 43 meters, deeper than the usual habitat of *M. oxytata,* to which it is closely related. The larger figured specimen (pl. 6, fig. 2) came from even deeper water, but was a dead shell that clearly had moved down-slope. According to Sunderland, the species is a member of a poorly known deep-water reef fauna, which includes numerous unique species.

MURICOPSIS (MURICOPSIS) ZYLMANAE
Petuch
Plate 4, figures 1-3

Muricopsis zylmanae PETUCH, 1993, La Conchiglia, Ann. 25, no. 266, p. 55, figs. 10, 11; SUNDERLAND and SUNDERLAND, 1993, Amer. Conchologist, v. 21, no. 4, p. 15, text-fig. (paratype).

Description: "Shell elongated, slender, with very protracted, elevated spire; shoulder ill-de-

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PLATE 6

Figures Page

1, 2. *Muricopsis (Muricopsis) sunderlandi* Petuch 66
1. (X 4; protoconch X 10) USNM 859848 (holotype); height 12.6 mm, diameter 8.8 mm.
Locality: Cay Sal Bank, Bahama Islands. Recent.
2. (X 3) USNM 880010; height 22.7 mm, diameter 15.1 mm (including spines).
Locality: R/V *Silver Bay* Station 3495, Bahama Islands. Recent.
3, 4. *Muricopsis (Muricopsis) marcusi* Vokes, n. sp 70
3. (X 2 1/4) MORG 31.961 (holotype); height 29.7 mm, diameter 16.3 mm.
Locality: Cabra Island, Ilhabela, São Paulo, Brazil. Recent.
4. (X 2 1/4) MORG 31.962 (paratype); height 27.2 mm, diameter 15.0 mm.
Locality: same as holotype.
5, 6. *Muricopsis (Muricopsis) josei* Vokes, n. sp 69
5. (X 2 1/2) MORG 31.963 (holotype); height 21.5 mm, diameter 12.9 mm.
Locality: Guarapari, Espírito Santo, Brazil. Recent.
6. (X 5) MORG 31.964 (paratype); height 9.6 mm, diameter 4.8 mm.
Locality: same as holotype.

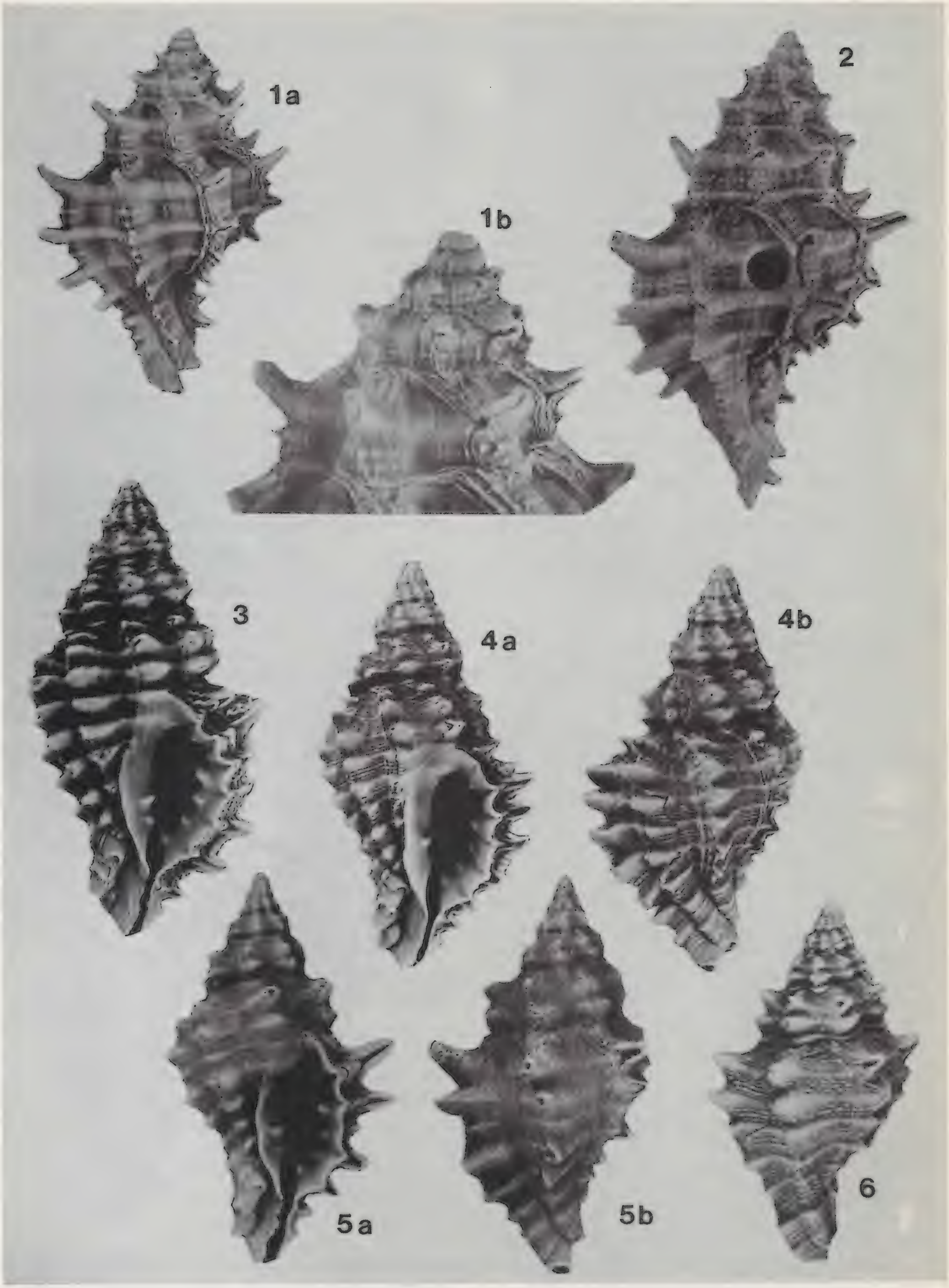


PLATE 6

fined, somewhat rounded; whorls with 6 thin, bladelike varices; intervarical areas smooth, without scales or spinelets, weakly sculptured with very faint, fine spiral threads; body whorl varices with 3 extremely large, well developed, needle-like spines; areas between spines on varices ornamented with few very reduced, tiny knoblike spinelets; siphonal canal proportionally very long, well-developed, ornamented with single large, needle-like spine; varices aligned in curved rows, producing spiral pattern on spire; spire, body whorl, and siphonal canal colored golden-tan with darker tan areas between varices; spines colored bright rose-pink; tip of siphonal canal pink." (Petuch, 1993)

Holotype: CMNH 47379; height 32.0 mm, diameter 18.5 mm.

Type locality: Off Great Isaacs Cay, Bahama Islands.

Occurrence: Recent only, Bahama Islands.

Figured specimens: Fig. 1, CMNH 47379 (holotype). Fig. 2, Sunderland Collection (paratype); height 46.1 mm, diameter 34.0 mm (including spines); locality, Cay Sal Bank, Bahama Islands, 24 meters. Fig. 3, Stephens Collection; height 26.7 mm, diameter 17.2 mm (including spines); locality, Cay Sal Bank, Bahama Islands, 24 meters.

Discussion: Although it was stated in the original description (Petuch, 1993, p. 56) that this species differs from the similar appearing *M. oxytata* in having only three spines on each body whorl varix, in contrast to the four of *M. oxytata,* the holotype is a broken specimen and, as may be seen in the better paratype (pl. 4, fig. 2), *M. zylmanae* also has a smaller fourth spine. In fact, it is extremely difficult to separate juvenile shells of *M. zylmanae* from similar sized, long-spined examples of *M. oxytata* (compare pl. 4, figs. 3, 4). But, in fully adult specimens the overall shape of the shell is different. *Muricopsis oxytata* has the typical *Muricopsis*-like biconic outline and *M. zylmanae* has an inflated body whorl sharply constricted into a narrow siphonal canal.

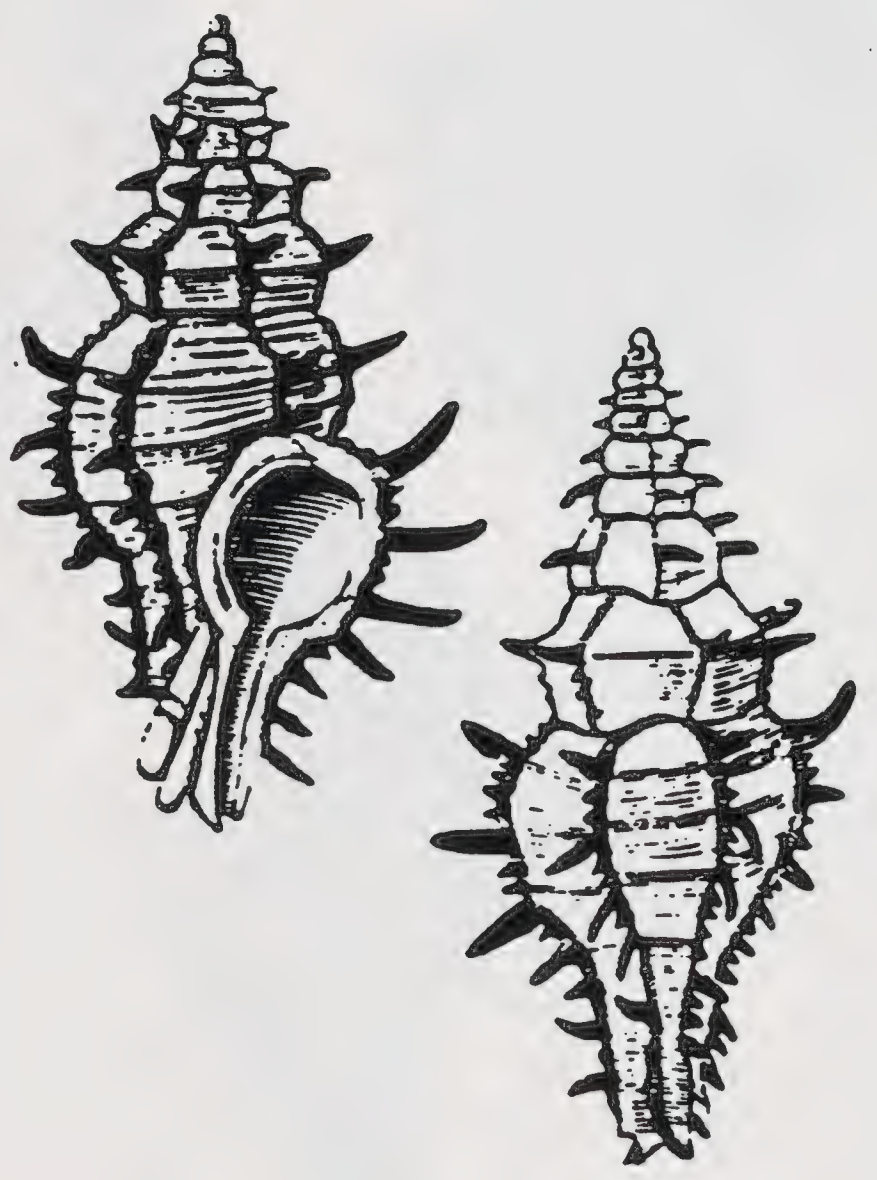
Although the varical spines are extremely long in *M. zylmanae,* there are also long-spined examples of *M. oxytata,* so that only in the fully adult shell is this a valid distinction. To further complicate the picture, there are long-spined examples of *M. oxytata* that occur together with *M. zylmanae* in the Bahamas, as demonstrated by Sunderland and Sunderland (1993, p. 15, text-fig.).

An even greater complication is Lamarck's original illustration (1816, pl. 418, figs. 3a, 3b) of *Murex hexagonus* (text-fig. 1), which more nearly resembles specimens of *M. zylmanae* than of *M. oxytata.* Inasmuch as the name *M. hexagonus* Lamarck is preoccupied by that of Gmelin, 1791, this creates no nomenclatorial problem, but it does cause one to wonder. Likewise, the specimen illustrated as *M. oxytata* by Radwin and D'Attilio (1976, pl. 27, fig. 5), from Guantanamo Bay, Cuba, has the general body shape of *M. zylmanae* but the shorter spines of *M. oxytata.*

MURICOPSIS (MURICOPSIS) PEREXIGUA
Vokes, n. sp.
Plate 4, figures 5, 6

Pygmaepterys sp. SUNDERLAND and SUNDERLAND, 1993, Amer. Conchologist, v. 21, no. 4, p. 15, text-fig.

Description: Shell angulately biconic, with only four teleoconch whorls in largest specimen seen. Protoconch of one and one-half high, tabulate whorls, sometimes slightly keeled; transition to teleoconch not marked by varix but



Text-figure 1. *Murex hexagonus* Lamarck, 1816, pl. 418, figs. 3a, 3b (X 1 1/2; original illustration 38.5 mm).

only by onset of spiral and axial ornamentation. Spiral ornamentation on first teleoconch whorl of two flattened cords, one at shoulder and one at midpoint of whorl. On second teleoconch whorl another cord developed on subsutural ramp, and on third whorl a fourth cord added between suture and median cord. On body whorl a total of eight major cords: one on subsutural ramp; two on siphonal canal; and five on body portion of whorl, with the one at the shoulder strongest. Secondary cords irregularly placed between major cords. Axial ornamentation on first teleoconch whorl of approximately 12 strap-like ridges, gradually becoming noded at intersection of spiral cords. Ridges increasing in strength and decreasing in number to eight on body whorl. On third teleoconch whorl small sharp spines appearing at intersection of axial ridges and spiral cord at shoulder; at intersection of other spirals only nodes present. Apertural varix with several layers of shell material and small open spines at intersection of each spiral cord, not visible on older varices (axial ridges) except at shoulder. Suture impressed. Aperture elongate-oval. Inner lip slightly appressed in posterior portion, free-standing along anterior portion, with two or three denticles on anterior half. On inner side of outer lip four denticles developed anterior to shoulder cord, the one nearest to shoulder strongest. Siphonal canal short, only slightly recurved at distal end. Shell color pink or white with apex pink; brown blotches at base of body whorl and on shoulder ramp between axial ridges.

Holotype: ANSP 374072; height 6.2 mm, diameter 3.7 mm.

Type locality: Grand Bahama Island, Bahama Islands.

Etymology of name: perexigua (Latin) – very small.

Occurrence: Recent only, known only from the type locality and Utila, Bay Islands, Honduras.

Figured specimens: Fig. 5, ANSP 374072 (holotype). Fig. 6, ANSP 397690 (paratype); height 5.8 mm, diameter 3.3 mm; locality same as holotype.

Discussion: This, the smallest species of western Atlantic *Muricopsis* (the Panamic *M. tulensis* Radwin and D'Attilio, 1976, is the same size, maximum height 7 mm) yet discovered, is based upon four specimens in the Worsfold Collection at the Academy of Natural Sciences, Philadelphia, and four additional specimens in the collection of Kevan and Linda Sunderland, Sunrise, Florida. All of the specimens are small; the largest (in the Sunderland Collection) measures only 7.0 mm in height. No example seen has more than four teleoconch whorls, although one would suspect that the shell would ultimately have five or six teleoconch whorls.

A paratype specimen of this new species was referred to *Pygmaepterys* by Sunderland and Sunderland (1993, p. 15, text-fig.) but that group is characterized by wing-like (rather than spinose) varices and the shell surface is covered by an elaborate filigree of axial growth lines crossed by spiral threads (see pls. 25, 26).

Muricopsis perexigua perhaps most nearly resembles the Panamic *M. pauxilla* (A. Adams, 1854), especially in the nature of the angulate protoconch; although it has a protoconch more nearly like that of another Panamic species, *M. jaliscoensis* Radwin and D'Attilio, 1970 (compare Radwin and D'Attilio, 1976, text-figs. 107 [*M. jaliscoensis*] and 108 [*M. pauxilla*]). From *M. pauxilla*, the new species differs in having a much less scabrous shell, which lacks the secondary and tertiary spiral ornamentation seen in the Pacific form. The color of the two species is also different with *M. pauxuilla* having a conspicuously marked black and white striped shell.

The only Atlantic species that bears more than a generic similarity to this new species is another new species, *M. josei*, named below from the coast of Brazil. The Brazilian shell is larger, with less pronounced spiral ornamentation and fewer varices per whorl.

MURICOPSIS (MURICOPSIS) JOSEI
Vokes, n. sp.
Plate 6, figures 5, 6

Description: Shell weakly biconic, with seven teleoconch whorls; protoconch of one and one-half smooth, bulbous whorls, ending at a small varix. Spiral ornamentation on early teleoconch whorls of two cords, visible only at intersection of axial ridges. On body whorl five major spiral cords, plus two on siphonal canal; very faint secondary threads covering entire surface of shell, both between and on top of major spiral cords. Axial ornamentation of nine narrow ridges on first teleoconch whorl, diminishing to six on third and all successive whorls. Where crossed by spiral cords, initially raised nodes present, but by third whorl, small open spines developed at each intersection. On body whorl only two anterior and two posterior major spiral cords with spines, the median cord lacking spines. An addi-

tional two rows of spines on siphonal canal. Suture slightly appressed. Aperture elongate-oval, inner lip smooth, free-standing almost entire length, appressed only at posteriormost portion. On anterior portion, two strong, elongate denticles, corresponding to the two spiral cords on siphonal canal. Inner side of outer lip with five denticles: three anteriormost relatively small; the fourth from anterior end much the strongest; the fifth, or posteriormost, slightly less so. Margin of outer lip scalloped in accordance with the varical spines. Siphonal canal short, recurved at distal end. Shell color tan, with varical spines a bit darker in some specimens. Aperture white. Operculum elongate, unguiculate, with terminal nucleus.

Holotype: MORG 31.963; height 21.5 mm, diameter 12.9 mm.

Type locality: Guarapari, Espírito Santo, Brazil, 10-15 meters, under dead coral.

Etymology of name: In honor of Jose Coltro, half of a pair of extraordinary collectors, the brothers Coltro of São Paulo, Brazil, who provided the type material.

Occurrence: Recent only, known only from northern Brazil.

Figured specimens: Fig. 5, MORG 31.963 (holotype). Fig. 6, MORG 31.964 (paratype); height 9.6 mm, diameter 4.8 mm; locality same as holotype.

Discussion: In recent years a number of new and interesting muricid species have been collected from the coast of Brazil by Jose and Marcus Coltro. Among them are two new species of *Muricopsis*. The two species are similar but differ in that the more northern of the two, collected at Guarapari, Espírito Santo, is smaller, lighter in color, and has six rather than eight varices, as does the southern form.

In overall appearance, *M. josei* most nearly resembles *M. quisqueyensis*, from the Gurabo Formation, Dominican Republic. The shell is almost smooth between the varices, each of which bears four short, blunt spines. There is a single non-spinose spiral cord, located between the anterior and posterior pairs of major spines. The aperture is like that of *M. blainvillei*, with two strong denticles on the columellar lip, which is somewhat more expanded than other American members of the genus.

The type lot consists of 11 specimens, the largest of which measures 26 mm in height; ten of these are from the type locality, where they were collected by the Coltro brothers on and under dead corals, in 10-15 meters depth. The eleventh is an unfigured paratype in the collections of the Museu Oceanográfico, Rio Grande do Sul (MORG 23.284), from Parcel dos Paredes, Abrolhos Archipelago, also taken on coral.

MURICOPSIS (MURICOPSIS) MARCUSI
Vokes, n. sp.
Plate 6, figures 3, 4

Description: Shell with seven teleoconch whorls; protoconch unknown. Spiral ornamentation on early teleoconch whorls of two cords; by second or third teleoconch whorl, a third added on shoulder ramp. On body whorl six major spiral cords, plus two on siphonal canal; secondary threads covering entire surface of shell between major spiral cords. Axial ornamentation of nine narrow ridges on first teleoconch whorl, diminishing to eight on third and all successive whorls. Where crossed by spiral cords, initially raised nodes present, gradually becoming more produced and by fourth or fifth teleoconch whorl small open spines on adapertural side of all nodes, becoming larger with each successive whorl. Axial ridges becoming varices, formed by multiple layers of shelly material. Suture slightly impressed. Aperture elongate-oval, inner lip smooth, free-standing almost entire length, appressed only at posteriormost portion. On anterior portion, two strong, elongate denticles, not corresponding to spiral cords on siphonal canal. Inner side of outer lip with five denticles: three anteriormost relatively small; the fourth from anterior end much the strongest; the fifth, or posteriormost, slightly less so. Margin of outer lip scalloped in accordance with the varical spines. Siphonal canal short, recurved at distal end. Shell color brown, with varical spines darker brown. Aperture white, with margin rimmed in brown. Operculum elongate, unguiculate, with terminal nucleus.

Holotype: MORG 31.961; height 29.7 mm, diameter 16.3 mm.

Type locality: Cabra Island, Ilhabela, São Paulo, Brazil, 5-7 meters, under stones.

Etymology of name: In honor of Marcus Coltro, the other half of that pair of remarkable Brazilian collectors, the brothers Coltro of São Paulo.

Occurrence: Recent only, known only northern Brazil.

Figured specimens: Fig. 3, MORG 31.961 (holotype). Fig. 4, MORG 31.962 (paratype); height 27.2 mm, diameter 15.0 mm; locality same as holotype.

Discussion: Because of its larger size and dark brown color this new species has a superficial resemblance to *Muricopsis (Risomurex) necocheana* (Pilsbry, 1900), whose range does overlap that of the new

species. However, *M. marcusi* has spinose varices in contrast to the rounded axial ridges seen in *M. (R.) necocheana.*

The new species more closely resembles the Mediterranean type of the genus (*M. blainvillei*) than any other American species. From the latter, *M. marcusi* may be distinguished by the non-scabrous surface, marked by six major spiral cords, with only faint secondary threads between them, where in *M. blainvillei* there is a more prominent secondary cord flanked by tertiary threads on either side, between each pair of major cords. As with *M. josei,* the aperture is like that of *M. blainvillei,* with strong denticles on the expanded columellar lip.

The type lot consists of nine specimens, the largest of which measures 28.5 mm in height. Eight of these were collected at the type locality, under rocks in 5-7 meters. The ninth is an unfigured paratype in the collections of the Museu Oceanográfico, Rio Grande do Sul (MORG 23.739), Ilha São Sebastião, São Paulo, taken intertidally from rocks.

Subgenus RISOMUREX
Olsson and McGinty, 1958

Risomurex OLSSON and MCGINTY, 1958, Bulls. Amer. Paleontology, v. 39, no. 177, p. 40.

Type species: *Ricinula deformis* Reeve, 1846, ICZN Opinion 1623 (1991).

Discussion: The subgenus *Risomurex* has been monographed by Vokes and Houart (1986) and there is little new information to be added. Therefore, the synonymies of the species below are abbreviated to include only the more important references. The reader is referred to this previous study for more discussion on the various species.

The type species of this taxon was originally designated by the authors as *Engina schrammi* Crosse, 1863; however, the shell that they illustrated for the type is not Crosse's species but one named earlier as *Ricinula deformis* Reeve, 1846. At the time of the Vokes and Houart study, the type designation was in a state of confusion and Kemperman and Coomans had applied to the *International Commission on Zoological Nomenclature* to have their newly described *Risomurex mosquitensis* designated as the type species.

Vokes and Houart (1986, 1989) expressed the opinion that *R. mosquitensis* is a subjective synonym of *R. deformis* and a better course of action would be to declare the latter as type, inasmuch as, at that time, it was believed that *Engina schrammi* was a subjective synonym of *R. rosea* (Reeve, 1846).

Although a second specimen of *R. schrammi* has been discovered (Houart, 1990), indicating that the form is a valid species, the fact that it was *Ricinula deformis* which Olsson and McGinty had in mind when they originally proposed the taxon caused the Commission to vote to designate the latter species as type of *Risomurex* Olsson and McGinty, 1958 (ICZN Opinion 1623, March, 1991).

Members of the subgenus *Risomurex* are differentiated from *Muricopsis* s.s. by the lack of true varices, instead having the shells marked by strong axial ridges. These, when crossed by the spiral cords, form more or less pronounced nodules. In many species there is a keeled protoconch, but this is not invariable and is not considered to be a subgeneric characteristic.

At the time of the Vokes and Houart paper (1986) species of *Risomurex* were known only from the Atlantic Ocean, both eastern and western sides. Since that time, however, two species have been described from the northwestern Indian Ocean: *Muricopsis omanensis* Smythe and Oliver (1986, p. 181, pls. 18, 19) and *M. chiarae* Bozzetti (1991, p. 44, figs. 4, 5; which may be synonymous with *M. omanensis*), from off Somalia. These non-Atlantic species of *Risomurex* bear a strong resemblance to the South American species, *M.(R.) withrowi,* having seven axial ridges and a light brown shell with darker brown lines topping the spiral cords. The geologic connection between these two very disjunct occurrences is not known.

MURICOPSIS (RISOMUREX) ASPINOSA (Meyer)
Plate 7, figures 1, 2

Murex simplex Aldrich var. *aspinosus* MEYER, 1886, Alabama Geol. Surv., Bull. 1, pt. 2, p. 74, pl. 2, fig. 21.

[Urosalpinx] aspinosa (Meyer). DALL, 1890, Wagner Free Inst. Sci., Trans, v. 3, pt. 1, p.

147; COSSMANN, 1903, Essais Paléoconch. Comp., v. 5, p. 50.

[Poirieria (Panamurex)] aspinosus (Meyer). VOKES, 1964, Malacologia, v. 2, no. 1, p. 18.

?*Urosalpinx aspinosus* (Meyer). MACNEIL and DOCKERY, 1984, Mississippi Dept. Nat. Res., Bur. Geol., Bull. 124, p. 127, pl. 5, figs. 6 (holotype), 7, 8.

Description: "Ovate; whorls convex, with obtuse, transverse ribs – seven on the body whorl; covered by elevated, sharp, distinct, revolving lines, which on the older whorls alternate with faint ones; canal nearly straight; outer lip thickened, crenulate within; callus of inner lip with three obtuse teeth." (Meyer, 1886)

Holotype: USNM 644592; height 12.4 mm, diameter 6.5 mm.

Type locality: Red Bluff, Chickasawhay River, Wayne County, Mississippi (= TU 1288).

Occurrence: Red Bluff Formation, Mississippi.

Figured specimens: Fig. 1, USNM 645622; height 17.8 mm, diameter 9.0 mm; locality TU 226. Fig. 2, USNM 482020; height 13.0 mm, diameter 6.3 mm; locality, Mississippi Geol. Surv. 35a, Chickasawhay River, Wayne County, Mississippi. Additional locality: TU 642.

Discussion: Muricopsis aspinosa previously was assigned (Vokes, 1964, p. 18) to *Poirieria (Panamurex)* on the basis of the labral and columellar denticulations*, but subsequent work has indicated that this placement is erroneus. The apertural denticles, the high spire, and short siphonal canal, plus the lack of varical spines suggests that *Risomurex* is a better assignment. However, even this is a compromise. The main reason to place *M. aspinosa* herein is the similarity to *M. crassicosta* (Benoist), which follows, rather than a strong resemblance to the later members of the subgenus.

Although the species is known only from the vicinity of the type locality along the Chickasawhay River, it is not rare there, we have numerous specimens in the Tulane Collections and MacNeil and Dockery reported it from three additional localities in the same general area (USGS 2633, 5263, MGS 40).

MacNeil and Dockery (1984, p. 127) stated that the nature of the complete protoconch is not known; however, one example subsequently collected by Dockery at Mississippi Geological Survey locality 35a (Red Bluff Formation) shows the species to have a typical "primitive" muricid protoconch of four smooth, conical whorls (see pl. 7, fig. 2). Inasmuch as the Miocene *M. crassicosta* has the more advanced type of protoconch with one and one-half bulbous whorls, it is assumed that the keeled protoconch of the modern species is an even more advanced development. This is consistent with the fact that not all species in the subgenus have a keeled protoconch, and it is not considered a subgeneric character.

Muricopsis aspinosa was originally named as a variety of the Vicksburg species *Poirieria (Panamurex) macneili* Vokes [new name for *Murex simplex* Aldrich *non* Philippi] but, as Dall (1890, p. 147) pointed out, the two forms are not closely related.

Muricopsis (Risomurex) crassicosta (Benoist)
Plate 7, figure 3

Jania crassicosta BENOIST, 1873, Cat. Saucats, p. 349.

Muricopsis crassicosta (Benoist). COSSMANN and PEYROT, 1923, Linn. Soc. Bordeaux, Actes, v. 75, p. 142, pl. 15, fig. 5 (said also to be fig. 6, but not found).

Muricopsis (Risomurex) crassicosta (Benoist). VOKES and HOUART, 1986, Tulane Stud. Geol. Paleont., v. 19, no. 2, p. 84, pl. 3, figs. 6, 7.

Description: "Shell large for the subgenus, to 21 mm in height; solid and heavy. Aperture ovate and narrow; columellar lip with two elongate nodes anteriorly; anal notch moderately deep; outer apertural lip crenulate, five strong denticles on the inner side, the second being the strongest. Spire high; protoconch of one and one-half rounded whorls; eight or nine slightly angulate postnuclear whorls. Suture impressed, undulated by axial ridges. Body whorl with eight heavy, low axial ridges, crossed by eight or nine spiral cords: one on the shoulder, five or six on the body, and two on the siphonal canal; between each pair of major cords two fine squamose threads. At the intersection of the spiral cords and axial ridges low, elongate nodes developed; spiral cords forming five or six short spines on apertural varix. Siphonal canal open, short, wide and slightly recurved dorsally." (Vokes and Houart, 1986)

Neotype: Cossmann Collection, Dept. de

*MacNeil and Dockery (1984, p. 127) note that in this species the "columellar denticles are irregular in both shape and number (2 to 5)" but most specimens have three such denticles.

Paléontologie, Université Paris (VI); height 21 mm, diameter 10 mm (*fide* Cossmann and Peyrot, 1923, p. 143).

Type locality: Saucats (about 25 km south of Bordeaux), France.

Occurrence: Chipola Formation, Florida; Cantaure Formation, Venezuela; Burdigalian, France.

Figured specimen: USNM 377395; height 16.0 mm, diameter 8.5 mm; locality TU 555. Additional localities: TU 547, 830, 951, 1048; NMB 17515, 17516.

Discussion: This, the oldest species unquestionably referable to the subgenus *Risomurex,* occurs in the Chipola Formation of Florida and the correlative Cantaure Formation of Venezuela, as well as in the Burdigalian beds near Saucats, France. The shell is marked by eight rounded axial ridges crossed by eight or nine spiral cords, which, under ultraviolet light, show a color pattern of darker lines topping them (see Vokes and Houart, 1986, pl. 3, fig. 7b). The protoconch is not keeled, as are most of the later species, and this is assumed to be a less advanced character.

The species has not been reported previously from the Cantaure Formation, but in the Gibson Smith Collection, now at the Naturhistorisches Museum, Basel, Switzerland, there are several specimens from Casa Cantaure, Paraguaná Peninsula, Venezuela (= TU 1269).

MURICOPSIS (RISOMUREX) GALBENSIS (Jung)
Plate 7, figure 4

Risomurex galbensis JUNG, 1969, Bulls. Amer. Paleontology, v. 55, no. 247, p. 495, pl. 50, figs. 10-13.

Muricopsis (Risomurex) galbensis (Jung). VOKES and HOUART, 1986, Tulane Stud. Geol. Paleont., v. 19, no. 2, p. 83, pl. 2, fig. 6.

Description: "Small, stout. Protoconch consists of a little less than 1 1/2 smooth whorls. It is strongly keeled and flattened above forming a depression at the apex. Postnuclear whorls about five. Early sculpture consists of axials (about 10 on first sculptured whorl) and two spirals form beads at the intersections. On subsequent whorls the axials become much stronger, and the upper spiral forms a shoulder with acute nodes, where the axials cross. On the second or third sculptured whorl another spiral appears close to the lower suture which is noded as well. Spaces between spirals ornamented by several fine spirals. Body whorl with six to seven noded spirals and eight axials, the last ones being varix-like. Unworn specimens show undulating, somewhat lamellar growth lines. Outer lip thick, with five denticles on inner surface. Inner lip with two inconspicuous lirae on lower part. Anterior canal short. Siphonal fasciole inconspicuous." (Jung, 1969)

Holotype: USNM 645367; height 13.8 mm, diameter 7.7 mm.

Type locality: Courbaril Sand Member, Morne l'Enfer Formation; Pt. Courbaril, Trinidad.

Occurrence: Morne l'Enfer Formation, Trinidad.

Figured specimen: USNM 645367 (holotype).

Discussion: Muricopsis (Risomurex) galbensis is a common species in the Early Pliocene Courbaril Sand Member of the Morne l'Enfer Formation of Trinidad (Jung, 1969, p. 495) but it has not been reported elsewhere.

MURICOPSIS (RISOMUREX) GILBERTHARRISI (Weisbord)
Plate 7, figure 5

Drupa (Morula) gilbertharrisi WEISBORD, 1962, Bulls. Amer. Paleontology, v. 42, no. 193, p. 295, pl. 26, figs. 12-14.

Muricopsis (Risomurex) gilbertharrisi (Weisbord). VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 214; VOKES and HOUART, 1986, Tulane Stud. Geol. Paleont., v. 19, no. 2, p. 78, pl. 3, figs. 1-3.

Muricopsis gilbertharrisi (Weisbord). SUNDERLAND and SUNDERLAND, 1993, Amer. Conchologist, v. 21, no. 4, p. 14, text-fig.

Description: "Shell of medium size, slenderly biconical, the spire acuminate, a little shorter than the body. Whorls 8 1/2 in all, the smooth nucleus composed of 1-1/2 of them. Initial turn of the nucleus somewhat globose and a little inclined, the last spirally carinate, the carina starting at the top of the whorl and descending obliquely to the conch where it is then at the middle of the whorl. The nucleus is defined from the conch by a narrow axial groove on the forward side of which the sculpture of the shell begins. First three post-nuclear whorls slightly convex, bearing strong nodulose evenly spaced axial costae and three plain spiral cords separated by equal interspaces, the cords connecting the nodules and passing across them in diminished strength. Remaining whorls moderately convex, with 12 equal tuberculate axial folds, each fold with three tubercles, the tubercles becoming progressively more elongate spirally on the lower portion of the shell, the right half of each tubercle a little more attenuated than the left, the drawn and somewhat sunken ends tending to join those of the adjacent tubercles. Between

each row of tubercles there are two or three raised spiral threads or cords, the threads crenulated, beaded, or rendered scabrous by the numerous fine axial lamellae which traverse the surface. Body whorl with two to four raised spirals between each row of tubercles, the top and bottom ones in the interspace lying immediately adjacent to the row of tubercles; where the spiral thread is present, and this is generally the case, it lies about midway between the other two, and is slightly larger; where four spiral cords are present the middle two are about equal and are larger than the ones above and below. Sutures fine. Anterior fasciole prominent, convex, marked with 8 to 10 strong cords crossed by 6 vaulted growth incrementals. Between the fasciole and the inner lip there is an umbilicus-like depression. Aperture lenticular. Outer lip thickened behind by an axial fold larger than the ones on the dorsum, the forward side of the fold built up with vaulted axial lamellae. Rim of outer lip frilled or closely scalloped. Interior of outer lip armed with five rounded denticles, the uppermost bordering the posterior canal; the topmost of the four remaining denticles is the largest of all and is situated a little above the middle of the lip; the three denticles are subequal in size, the lowest one lying near the entrance to the siphonal canal. Inner lip with a white callus, adherent on the parietal wall but the distal edge detached and sheath-like below. Columella with three raised welts, the upper-

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1, 2. *Muricopsis (Risomurex) aspinosa* (Meyer) 71
1. (X 3) USNM 645622; height 17.8 mm, diameter 9.0 mm.
Locality: TU 226, Chickasawhay River, Mississippi. Red Bluff Formation.
2. (X 10) USNM 482020; height 13.0 mm, diameter 6.3 mm.
Locality: Mississippi Geol. Surv. 35a, Chickasawhay River, Mississippi. Red Bluff Formation.
3. *Muricopsis (Risomurex) crassicosta* (Benoist) 72
(X 3) USNM 377395; height 16.0 mm, diameter 8.5 mm.
Locality: TU 555, Chipola River, Florida. Chipola Formation.
4. *Muricopsis (Risomurex) galbensis* (Jung) 73
(X 3 1/2) USNM 645367 (holotype); height 13.8 mm, diameter 7.7 mm.
Locality: Pt. Courbaril, Trinidad. Courbaril Sand Member, Morne l'Enfer Formation.
5. *Muricopsis (Risomurex) gilbertharrisi* (Weisbord) 73
(X 2 1/2) PRI 26205 (holotype); height 20.5 mm, diameter 9.9 mm.
Locality: Quebrada Mare Abajo, Cabo Blanco, Venezuela. Mare Formation.
6, 7. *Muricopsis (Risomurex) deformis* (Reeve) 76
6. (X 3 1/2) USNM 820638; height 14.7 mm, diameter 8.7 mm.
Locality: TU R-109, Bahia de las Minas, Panama. Recent.
7. (X 4) USNM 482021; height 11.1 mm, diameter 6.6 mm.
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8. *Muricopsis (Risomurex) schrammi* (Crosse) 77
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9. *Muricopsis (Risomurex) rosea* (Reeve) 78
(X 4) Robinson Collection; height 11.5 mm, diameter 6.4 mm.
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10. *Muricopsis (Risomurex) caribbaea* (Bartsch and Rehder) 78
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11. *Muricopsis (Risomurex) withrowi* Vokes and Houart 79
(X 2 1/2) IRSNB I.G. 26,738/407 (paratype); height 19.5 mm, diameter 10.0 mm.
Locality: off Riohacha, Colombia. Recent.
12. *Muricopsis (?Risomurex) necocheana* (Pilsbry) 80
(X 3) Vokes Collection; height 19.4 mm, diameter 9.8 mm.
Locality: Cabo Frio, Brazil. Recent.

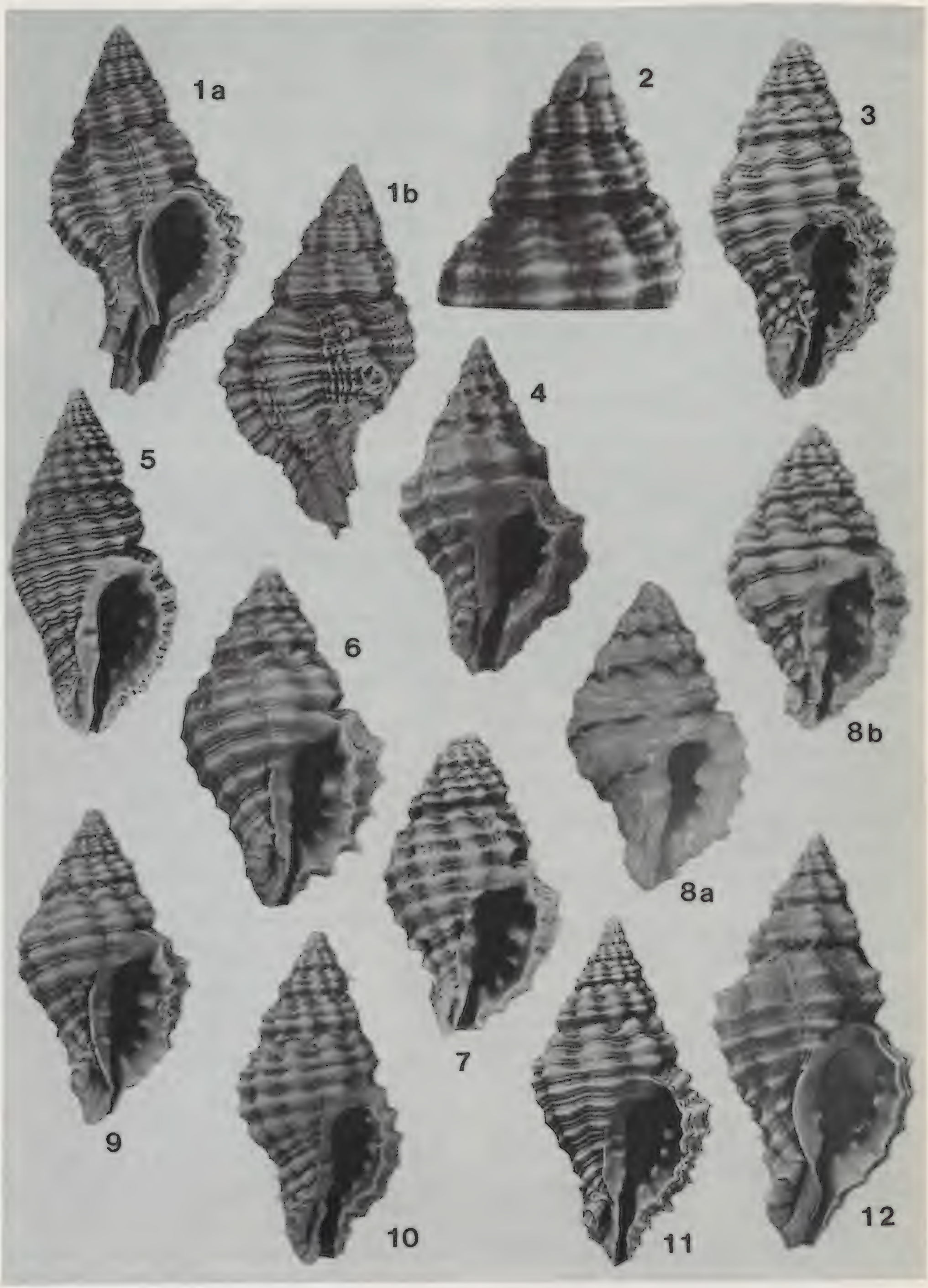

PLATE 7

most roundish, the next, close by, larger and horizontally elongate, the lowest a faint fold or plica. Anterior canal relatively long and deep, excavated into a small U-shaped terminal notch. Posterior canal shallow and fairly broad, bordered below on the parietal side by a thickening of callus which partially covers the last tubercle on the spiral cord extending across the upper portion of the parietal wall. The ground color of the surface and of the aperture is pure white. The tubercles of the ultimate and penultimate whorls are light brown. On the 2 whorls above the penultima, the upper and lower rows of tubercles are brown, the middle one glassy white. On the next whorl above, the tubercles are brown only on the topmost row, and above that the whorls are wholly of an off-white shade." (Weisbord, 1962)

Holotype: PRI 26205; height 20.5 mm, diameter 9.9 mm.

Type locality: Mare Formation; stream 100 meters west of Quebrada Mare Abajo, Cabo Blanco, Venezuela.

Occurrence: Mare Formation, Venezuela; Recent, eastern Venezuela.

Figured specimen: PRI 26205 (holotype).

Discussion: Although described from the Late Pliocene Mare Formation, this species has been discovered living along the coast of Venezuela today. It is found in the same general area as the similar *M. withrowi,* which occurs to the east, west, and north of it, but nowhere are the two found together. The reason for this curious distribution is not known.

Muricopsis (Risomurex) deformis (Reeve)
Plate 7, figures 6, 7

Ricinula deformis REEVE, 1846 [plate dated "1856" in error], Conch. Icon., v. 3, *Ricinula*, pl. 6, fig. 44.

Sistrum ferrugineum [sic] rubidum DALL, 1889, Harvard Mus. Comp. Zool., Bull., v. 18, p. 217.

Risomurex schrammi (Crosse). OLSSON and MCGINTY, 1958, Bulls. Amer. Paleontology, v. 39, no. 177, p. 41, pl. 2, fig. 2; KAICHER, 1979, Card Catalogue World-wide Shells, pack 20, Muricidae – Part IV, no. 2010 (*not* of Crosse).

Risomurex roseus (Reeve). WARMKE and ABBOTT, 1961, Caribbean Seashells, p. 106, pl. 19b (*not* of Reeve).

Muricopsis schrammi (Crosse). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 171, pl. 2, fig. 1, text-fig. 111 (worn protoconch), 112 (radula); [?] SUNDERLAND and SUNDERLAND, 1993, Amer. Conchologist, v. 21, no. 4, p. 14, text-fig. (*not* of Crosse).

Risomurex deformis (Reeve). KEMPERMAN and COOMANS, 1984, Zool. Mus. Univ. Amsterdam, Bull., v. 10, no. 1, p. 5, fig. 5 (holotype); KAICHER, 1991, Card Catalogue World-wide Shells, pack 59, Muricidae – Part VI, no. 6066.

Risomurex mosquitensis KEMPERMAN and COOMANS, 1984, Zool. Mus. Univ. Amsterdam, Bull., v. 10, no. 1, p. 1, figs. 3, 4.

Muricopsis (Risomurex) deformis (Reeve). VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 214; VOKES and HOUART, 1986, Tulane Stud. Geol. Paleont., v. 19, no. 2, p. 66, pl. 2, figs. 1-5 (fig. 1, holotype – *R. deformis;* fig. 4, holotype – *S. rubidum* Dall; fig. 5, holotype – *R. mosquitensis* Kemperman and Coomans); HOUART, 1990, Amer. Conchologist, v. 18, no. 1, p. 8, fig. 5 (color plate).

Murex (Risomurex) deformis (Reeve). SUNDERLAND and SUNDERLAND, 1993, Amer. Conchologist, v. 21, no. 4, p. 14, text-fig.

Description: "Shell ovate, attenuated at the base, spire peculiarly shortened; longitudinally plicated, transversely nodosely ridged, lip thickened; transverse ridges and interstices alternately reddish yellow and brown." (Reeve, 1846)

Holotype: BMNH 196872; height 8.8 mm, diameter 5.8 mm.

Type locality: TU R-366, Punta Cahuita, Costa Rica (designated by Vokes and Houart, 1986, p. 66).

Occurrence: Moín Formation, Costa Rica; Recent, Caribbean Sea from Cuba, eastern Yucatan, along the coast of central America from Bay Islands, Honduras to Costa Rica and Panama.

Figured specimens: Fig. 6, USNM 820638; height 14.7 mm, diameter 8.7 mm; locality TU R-109. Fig. 7, USNM 482021; height 11.1 mm, diameter 6.6 mm; locality TU 1489.

Discussion: It is ironic that the species named *Ricinula deformis* Reeve should have been completely overlooked by workers for 140 years only to be "rediscovered" by two different sets of workers almost simultaneously. Vokes and Houart (1986) determined that Reeve's name was the correct one to be applied to the species figured as type of the subgenus *Risomurex* by Olsson and McGinty, but Kemperman and Coomans (1984) arrived at a slightly different intrepretation. In their opinion the species figured by Olsson and McGinty as type of *Risomurex* is an unnamed species to which they gave the name *Risomurex mosquitensis.* This new species they believed to be similar to *R. deformis* but not the same. All of the relevant mate-

rial was figured in Vokes and Houart (1986, pl. 2, figs. 1-5) and there seems little doubt that the "*R. schrammi*" of Olsson and McGinty is the same as *Ricinula deformis* Reeve, *Sistrum rubidum* Dall, and *Risomurex mosquitensis* Kemperman and Coomans.

The species *M.(R.) deformis* has not been reported previously as fossil but, in an unpublished dissertation, Robinson (1991, p. 402, pl. 17, fig. 9) figured a specimen from the Pleistocene Moín Formation of Costa Rica (refigured here, pl. 7, fig. 7). As Robinson noted, this is a common species in shallow water under coral rubble along the coast of Panama and Costa Rica today.

MURICOPSIS (RISOMUREX) SCHRAMMI
(Crosse)
Plate 7, figure 8

Engina schrammi CROSSE, 1863, Jour. de Conchyl., v. 11, p. 82, pl. 1, fig. 7.

Not *Risomurex schrammi* (Crosse). OLSSON and MCGINTY, 1958, Bulls. Amer. Paleontology, v. 39, no. 177, p. 41, pl. 2, figs. 2, 2a [= *M. deformis* (Reeve)].

Risomurex schrammi (Crosse). KEMPERMAN and COOMANS, 1984, Zool. Mus. Univ. Amsterdam, Bull., v. 10, no. 1, p. 3, figs. 6 (holotype), 7 (J. de C., v. 11, pl. 1, fig. 7).

Muricopsis (Risomurex) schrammi (Crosse). VOKES and HOUART, 1986, Tulane Stud. Geol. Paleont., v. 19, no. 2, p. 76, pl. 1, fig. 1 (holotype); HOUART, 1990, Amer. Conchologist, v. 18, no. 1, p. 8, figs. 1, 2 (holotype; color plate).

Not *Risomurex schrammi* (Crosse) KAICHER, 1991, Card Catalogue World-wide Shells, pack 59, Muricidae – Part VI, no. 2010/6053 [= *M. withrowi* Vokes and Houart].

Not *Muricopsis schrammi* (Crosse). SUNDERLAND and SUNDERLAND, 1993, Amer. Conchologist, v. 21, no. 4, p. 14, text-fig. [? = *M. deformis* (Reeve)].

Description: "Coquille imperforée, épaisse, subglobuleuse, atténuée aux deux extrémités et de couleur rose. Les tours de spire, au nombre de cinq, sont legérèment convexes, munis de côtes longitudinales obtuses, et ornés transversalement de nombreuses et élégantes lignes de nodulations: une seule de ces lignes, placée près de la suture, est d'un brun noirâtre très-intense: sur le dernier tour les lignes transverses, d'un brun noirâtre, sont au nombre de trois, l'une près de la suture, la seconde vers la partie médiane du tour, la troisième plus près de la base. La columelle est ridée et comme plissée, le bord droit épais et armé de quatre dents, dont l'une (la plus rapprochée du point d'insertion) est plus grosse que les autres. L'ouverture est, à peu près, droite, resserrée par les dents marginales, et par suite étroite: son intérieur est d'un rose violacé. La base de la coquille est canaliculee et sensiblement prolongée." (Crosse, 1863)

Holotype: Coll. Jour. de Conchyl., MNHN, Paris; height 8.8 mm, diameter 5.5 mm.

Type locality: Guadeloupe, French Antilles.

Occurrence: Recent, French Antilles only, so far as known.

Figured specimen: Holotype.

Discussion: At the time this species was discussed previously (Vokes and Houart, 1986, p. 76), the holotype was the only known example; therefore, we concluded it probably was a faded, aberrant specimen of the more widespread *M. rosea* (Reeve). However, since that time a second example has been discovered and figured by Houart (1990, fig. 1). Thus, *M.(R.) schrammi* seems to be a valid species, which differs from *M.(R.) rosea*, primarily in its more inflated outline and its color pattern, which consists of a light colored shell with three dark spiral lines, one at the suture, one at the periphery, and one at the base of the body whorl.

As was discussed at length in the Vokes and Houart work, the name "*schrammi*" was erroneously applied to another species of *Risomurex* and was named as the type of the genus *Risomurex* by Olsson and McGinty (1958, p. 41, pl. 2, figs. 2, 2a). Subsequent authors have followed their determination and so the species correctly denominated *M. deformis* (Reeve) is frequently cited in the literature under the name "*schrammi*" (*e.g.*, Abbott, 1974, p. 184; Radwin and D'Attilio, 1976, p. 171, pl. 2, fig. 1). Most recently Sunderland and Sunderland (1993, p. 14, text-fig) have figured as *Muricopsis schrammi*, a specimen from Samaná, Dominican Republic. Examination of several specimens of this form in the Sunderland Collection shows that it is probably no more than an atypical color variant of *M. deformis*, the more typical form of which they also figure on the same page.

Because of the confusion over the identity of the type species of *Risomurex*, the *International Commission on Zoological Nomenclature* has declared *Ricinula deformis* Reeve, 1846, to be the type species of

Risomurex (ICZN Opinion 1623, March, 1991).

MURICOPSIS (RISOMUREX) ROSEA (Reeve)
Plate 7, figure 9

Ricinula rosea REEVE, 1846 [plate dated "1856" in error], Conch Icon., v. 3, *Ricinula,* pl. 6, fig. 46.

Risomurex roseus (Reeve). OLSSON and MCGINTY, 1958, Bulls. Amer. Paleontology, v. 39, no. 177, p. 41; HUMFREY, 1975, Sea Shells of the West Indies, p. 139, pl. 16, fig. 11; KAICHER, 1979, Card Catalogue World-wide Shells, pack 20, Muricidae – Part IV, no. 1996; KEMPERMAN and COOMANS, 1984, Zool. Mus. Univ. Amsterdam, Bull., v. 10, no. 1, p. 5, fig. 8 (syntype); SARASÚA and ESPINOSA, 1984, Poeyana, no. 273, p. 4, fig. 2A; DE JONG and COOMANS, 1988, Stud. Fauna Curaçao, Caribbean Islands, v. 49, p. 75.

Not *Risomurex roseus* (Reeve). WARMKE and ABBOTT, 1961, Caribbean Seashells, p. 106, pl. 19b [= *M. deformis* (Reeve)].

Muricopsis roseus (Reeve) RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 170, pl. 2, fig. 5, text-fig. 109 (protoconch), *not* text-fig. 110 [radula of (?)*Trachypollia nodulosa* (Adams)].

Morula rosea (Reeve) CERNOHORSKY, 1978, Rec. Auckland Inst. Mus., v. 15, p. 76, fig. 23 (syntype).

Risomurex rutilis (Reeve). VOKES and VOKES, 1983, Mesoamer. Ecol. Inst., Mon. 1 (MARI Publ. 54), p. 24 (*not* of Reeve).

Muricopsis (Risomurex) roseus (Reeve). VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 214; VOKES and HOUART, 1986, Tulane Stud. Geol. Paleont., v. 19, no. 2, p. 68, pl. 1, figs. 5-9 (fig. 5, lectotype; fig. 6, paralectotype); HOUART, 1990, Amer. Conchologist, v. 18, no. 1, p. 8, fig. 3 (color plate); SUNDERLAND and SUNDERLAND, 1993, Amer. Conchologist, v. 21, no. 4, p. 14, text-fig.

Description: "Shell ovate, produced at the base, spire peculiarly shortened; whorls longitudinally nodosely ribbed, lip thickened, aperture small; rose-colour, zoned with brown." (Reeve, 1846)

Lectotype: BMNH 1968458 (designated by Vokes and Houart, 1986, p. 72); height 11.1 mm, diameter 6.4 mm.

Type locality: "Island of Masbate" [Philippine Islands]; St. Thomas, Virgin Islands (designated by Kemperman and Coomans, 1984, p. 5).

Occurrence: Recent only, throughout the Antilles to northern coast of South America.

Figured specimen: Robinson Collection; height 11.5 mm, diameter 6.4 mm; locality, Punta Rucia, Prov. Puerto Plata, Dominican Republic.

Discussion: As discussed in Vokes and Houart (1986, p. 72) this species has been plagued with mistakes beginning with Reeve (1846), who cited it as coming from the Philippine Islands (and who also put the wrong date on the plate). Although less common than *M. deformis* and *M. caribbeaa,* the species is widespread throughout the Antilles. There are no records from the mainland of North America or Central America, but a form believed to be a local color variant has been taken off northern South America.

MURICOPSIS (RISOMUREX) CARIBBAEA
(Bartsch and Rehder)
Plate 7, figure 10

Fusus muricoides C.B. ADAMS, 1845, Boston Soc. Nat. Hist., Proc., v. 2, p. 3; CLENCH and TURNER, 1950, Occ. Papers Moll., Harvard Univ., v. 1, no. 15, p. 313, pl. 39, fig. 9 (holotype) (*non Fusus muricoides* Deshayes, 1835.)

Tritonalia (Ocinebrina) caribbaea BARTSCH and REHDER, 1939, Smithsonian Misc. Coll., v. 98, no. 10, p. 7, pl. 1, fig. 1.

Ocenebra (Ocinebrina) muricoides (Adams). ABBOTT, 1954, Nautilus, v. 68, no. 2, p. 44, pl. 2, fig. 2 (holotype – *T. caribbaea*).

Risomurex muricoides (Adams). OLSSON and MCGINTY, 1958, Bulls. Amer. Paleontology, v. 39, no. 177, p. 41, pl. 2, fig. 1; HUMFREY, 1975, Sea Shells of the West Indies, p. 140, pl. 16, fig. 9; RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 168, pl. 2, fig. 3; KEMPERMAN and COOMANS, 1984, Zool. Mus. Univ. Amsterdam, Bull., v. 10, no. 1, p. 3, fig. 9; SARASÚA and ESPINOSA, 1984, Poeyana, no. 273, p. 4, fig. 2B.

Ocenebra (Risomurex) muricoides (Adams). ABBOTT, 1974, Amer. Seashells (ed. 2), p. 184, fig. 1922.

Risomurex caribbaeus (Bartsch and Rehder). VOKES and VOKES, 1983, Mesoamer. Ecol. Inst., Mon. 1 (MARI Publ. 54), p. 24, pl. 12, fig 4 (holotype – *F. muricoides* Adams); DE JONG and COOMANS, 1988, Stud. Fauna Curaçao, Caribbean Islands, v. 49, p. 75.

Muricopsis (Risomurex) caribbaeus (Bartsch and Rehder). VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 214; VOKES and HOUART, 1986, Tulane Stud. Geol. Paleont., v. 19, no. 2, p. 77, pl. 2, figs. 7-9 (fig. 7 = holotype – *F. muricoides* Adams, fig. 8 = holotype – *T. caribbaea,* fig. 9 = TU R-389; figs. 8 and 9 misnumbered); SUNDERLAND and

SUNDERLAND, 1993, Amer. Conchologist, v. 21, no. 4, p. 14, text-fig.

Description: "Shell small, very elongate-ovate, brown, with the spiral zone of tubercles above and below the peripheral keel and the 3 median columellar cords white. Aperture brown within with the external white bands marking the peristome; the denticles within the outer lip are also white. Nuclear whorls eroded. Postnuclear whorls marked by broad low axial ribs, of which 9 are present on the last turn; strong incremental lines also cross the whorls. The spiral sculpture consists of 3 very strong keels, which grow consecutively stronger from the first at the summit anteriorly. These cords pass across the intercostal spaces and the axial ribs, rendering these nodulose at their intersection. The nodules have their long axis coinciding with the spiral sculpture. Lesser spiral threads mark the spiral cords and the spaces between them. Suture moderately strongly constricted. Periphery with a spiral cord as strong as those posterior to it and similarly marked. Base short, well rounded with a heavy nodulose spiral cord on its middle and the finer sculpture noted for the spire. Columella long, somewhat twisted and marked by 2 slender spiral threads near its insertion, followed by 3 heavier cords, then a series of finer, more closely approximated threads near its tip. All this spiral sculpture is rendered roughened by incremental lines. Aperture decidedly channeled anteriorly; outer lip thick, marked at the edge by incremental lines bearing 5 denticles within the edge in the expanded portion of the aperture; inner lip appressed to the columella in its posterior half, free on the anterior part. Parietal wall glazed with a thin callus except near the outer lip where it develops into a low hump." (Bartsch and Rehder, 1939)

Holotype: USNM 472617; height 8.3 mm, diameter 4.0 mm.

Type locality: "Old Providence Island, Caribbean Sea" (= Isla de Providencia, Colombia).

Occurrence: Recent only, from Florida Keys throughout the Antilles and coast of Central America. Only occurrence in northern South America, from Isla La Tortuga (Vokes and Houart, 1986, p. 78).

Figured specimen: USNM 472617 (holotype).

Discussion: As noted in Vokes and Houart (1986, p. 77) workers have recognized that *"Tritonalia" caribbaea* is a junior synonym of *Fusus muricoides* C.B. Adams since Abbott's 1954 paper. What was not realized until Cernohorsky (1978, p. 78) called attention to it is the fact that *Fusus muricoides* Adams, 1845, is pre-occupied by *F. muricoides* Deshayes, 1835, a French Eocene species. Thus, *M.(R.) caribbaea* becomes the valid name for this well known and widely distributed species.

It should be noted that in Vokes and Houart the illustrations of the holotype of *Tritonalia caribbaea* and another specimen from the Dominican Republic (1986, pl. 2, figs. 8 and 9) are reversed.

MURICOPSIS (RISOMUREX) WITHROWI
Vokes and Houart
Plate 7, figure 11

Morula didyma (Schwengel). ABBOTT, 1974, Amer. Seashells (ed. 2), p. 177 (in part), fig. 1873 (*not* of Schwengel).

Muricopsis (Risomurex) n. sp. VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 214.

Muricopsis (Risomurex) withrowi VOKES and HOUART, 1986, Tulane Stud. Geol. Paleont., v. 19, no. 2, p. 78, pl. 3, figs. 4, 5; HOUART, 1990, Amer. Conchologist, v. 18, no. 1, p. 8, fig. 4 (color plate); SUNDERLAND and SUNDERLAND, 1993, Amer. Conchologist, v. 21, no. 4, p. 15, text-fig.

Risomurex withrowi (Vokes and Houart). DE JONG and COOMANS, 1988, Stud. Fauna Curaçao, Caribbean Islands, v. 49, p. 75, pl. 37, fig. 404; KAICHER, 1991, Card Catalogue World-wide Shells, pack 59, Muricidae – Part VI, without number.

Risomurex schrammi (Crosse). KAICHER, 1991, Card Catalogue World-wide Shells, pack 59, Muricidae – Part VI, no. 2010/6053 (*not* of Crosse).

Description: "Shell large for the subgenus, to 20 mm in height; solid and fusiform. Aperture ovate; columellar lip with two or three small denticles, reflecting the nodulose sculpture of the shell; adherent above and erect on about three-fourths of its anterior part; outer apertural lip crenulated, with five strong denticles on its inner side, the strongest being the second posterior one; anal notch deep and narrow. Spire high and acute; protoconch of one and one-half keeled whorls; six convex, slightly angulate postnuclear whorls. Suture impressed and slightly undulating. Body whorl with seven to nine low, broad axial ridges; no other axial sculpture except growth lamellae. Spiral sculpture consisting of eight major cords, more apparent and darker colored on the axial ribs, giving a nodulose appearance to the shell, and distributed as follows: one on the shoulder; five on the body; and two on the siphonal canal; two or three somewhat squamose threads intercalated between each pair of major spiral cords. Siphonal canal short, open, very slightly recurved dorsally at the tip. Color mauve or orange to light brown, or almost black with darker-colored spots where the spiral cords cross the ribs;

aperture white, edged by pink." (Vokes and Houart, 1986)

Holotype: USNM 779868; height 16.3 mm, diameter 9.0 mm.

Type locality: Curaçao, Netherlands Antilles.

Occurrence: Recent only, northern South America, from Colombia to Trinidad and Tobago.

Figured specimen: IRSNB I.G. 26,738/407 (paratype); height 19.5 mm, diameter 10.0 mm; locality, off Riohacha, Colombia.

Discussion: Muricopsis (Risomurex) withrowi is closely related to *M.(R.) gilbertharrisi,* which occurs in the same general northern South America region. However, as far as known, the ranges of the two species do not overlap. Described as a Pliocene fossil from Venezuela, *M. gilbertharrisi* lives today in a restricted area of eastern Venezuela and Isla de Margarita. The two forms are similar in appearance, with *M. gilbertharrisi* differing from *M. withrowi* in having a more narrow, elongated shell with more numerous axial ribs. The two may be ecologic variants of the same species but I have seen no intergrading examples.

MURICOPSIS (?RISOMUREX) NECOCHEANA (Pilsbry)
Plate 7, figure 12

Sistrum nicocheanum [sic] PILSBRY, 1900, Nautilus, v. 14, no. 1, p. 3.

Sistrum inglorium (Crosse). IHERING, 1907, An. Mus. Nac. Buenos Aires, v. 14 (ser. 3, v. 7), p. 447, with *S. necocheanum* [*sic*] in synonymy (*not* of Crosse).

Drupa (Drupa) necocheana (Pilsbry). CARCELLES, 1944, Rev. Mus. La Plata (n.s.), Sect. Zool., v. 3, p. 251, pl. 2, figs. 27, 29; CAMACHO, 1966, Paleontografia Bonaerense, fasc. 3, p. 134, pl. 16, fig. 11 (after Carcelles).

Morula necocheana (Pilsbry). RIOS, 1970, Coastal Brazilian Seashells, p. 81, pl. 24; RIOS, 1975, Brazilian Marine Moll. Icon., p. 92, pl. 27, fig. 381.

Muricopsis nicocheanus (Pilsbry). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 169, pl. 23, fig. 12.

Muricopsis necocheanus (Pilsbry). RIOS, 1985, Seashells of Brazil, p. 84, pl. 30, fig. 369.

Muricopsis (?Risomurex) necocheanus (Pilsbry). VOKES and HOUART, 1986, Tulane Stud. Geol. Paleont., v. 19, no. 2, p. 84, pl. 2, fig. 10.

Muricopsis (Risomurex) necocheanus (Pilsbry). HOUART, 1991, Nautilus, v. 105, no. 1, p. 31, text-fig. 11 (protoconch).

Muricopsis nicocheana (Pilsbry). SUNDERLAND and SUNDERLAND, 1993, Amer. Conchologist, v. 21, no. 4, p. 15, text-fig.

Description: "Shell imperforate or rimate, fusiform, thick and strong, brownish flesh-colored, the spiral lirae brown. Sculpture of strong, rounded, longitudinal waves equal to their intervals, 8 or 7 in number on the last whorl; these waves crossed by rather strong spiral cords, which widen into transversely oblong low tubercles upon the summits of the waves. Between these cords there are several spiral threads in most or all of the intervals. Whorls about 5 1/2, convex, the last one with concave outlines below, produced in a rather long anterior canal. Aperture oval, flesh-colored within; peristome thick or beveled, armed with six subequal teeth within; columellar margin angular at the origin of the anterior canal, bearing a single small transverse fold above the angle; canal rather straight and long for this genus." (Pilsbry, 1900)

Lectotype: ANSP 72640 (designated by Vokes and Houart, 1986, p. 84); height 21.5 mm, diameter 11.0 mm.

Type locality: "Nicochea" [= Necochea], Argentina.

Occurrence: Holocene and Recent, Espírito Santo, Brazil, to Bahia Blanca, Argentina.

Figured specimen: Vokes Collection; height 19.4 mm, diameter 9.8 mm; locality, Cabo Frio, Brazil.

Discussion: This temperate species is included only provisionally with *Risomurex* as there are certain differences in the nature of the labral denticles and in the non-keeled protoconch. However, the non-varicate shell is more similar to *Risomurex* than to *Muricopsis* s.s., and for this reason it is included in *Risomurex.*

Genus MUREXSUL Iredale, 1915

Murexsul IREDALE, 1915, New Zealand Inst., Trans. and Proc., v. 47, p. 471.

Type species: *Murex octogonus* Quoy and Gaimard, 1833, by original designation.

Discussion: Ponder (1972, p. 237) has questioned whether the taxa *Murexsul* and *Muricopsis* are separable. The differences between the two groups are more a matter of degree than any striking divergence. The type species of the two groups are completely distinctive but there are certain species that lie between the two.

However, the extreme development of the apertural denticles in typical species of

Muricopsis, and its subgenus *Risomurex*, is adequate to separate the two groups. I willingly grant that the group of *Muricopsis oxytata*, with its secondary loss of the apertural denticles, is a problem and that there are spinose species of *Muricopsis (e.g., M. zylmanae)* that could be placed equally well in either genus, but for the majority of the forms the similarities cause no difficulties. *Murexsul* posssibly could be considered a subgenus of *Muricopsis* but, as both groups go back to the Eocene in essentially unchanged morphology, there is little reason to unite them.

When I monographed the genus *Murexsul* (1968, p. 87) there was but a single fossil species, and no living ones, in the western Atlantic. Since that time several additional species have been added to the group, so that today the genus is known to be widely represented in both the western Atlantic and the eastern Pacific.

MUREXSUL species
Plate 8, figure 1

Occurrence: Bashi Marl Member, Hatchitigbee Formation, Alabama.

Figured specimen: USNM 482022; height 5.5 mm, diameter 3.8 mm; locality TU 87.

Discussion: From the Early Eocene Bashi Marl, near Butler, Alabama, we have collected a single juvenile specimen that represents the earliest known occurrence of the genus *Murexsul* in the New World. Although the specimen is clearly immature and has no apertural lip, its presence is worthy of note.

(?)MUREXSUL NANISSIMUS Vokes, n. sp.
Plate 8, figures 2-5

Description: Shell small (maximum height under 10 mm), six teleoconch whorls and a protoconch of one and one-half smooth, bulbous whorls, ending at a small straight varix. Spiral ornamentation on earliest teleoconch whorls of two strong rounded cords; by third teleoconch whorl a third slightly weaker cord added on shoulder ramp. By fourth teleoconch whorl spiral cords becoming lower and on body whorl five major cords, only slightly raised, alternating with secondary cords and tertiary threads. Axial ornamentation on first three teleoconch whorls of nine to ten small lamellar varices, marked by open spinelets at intersection of spiral cords. On fourth and successive whorls varices gradually decreasing to seven or eight per whorl and becoming only low rounded ridges. Surface made scabrous by intersection of numerous axial growth lamellae and spiral ornamentation. Suture impressed, undulated by axial ridges. Aperture elongate-oval; inner lip narrow, smooth, free-standing in anterior portion, slightly appressed in posterior portion. Inner side of outer lip with six elongate denticles, the posteriormost slightly larger, forming a weak, adapically-directed, anal notch. Siphonal canal short, broad, recurved at distal end.

Holotype: USNM 482023; height 8.6 mm, diameter 4.5 mm.

Type locality: TU 825, Chipola Formation; Farley Creek, at abandoned mill about 1/2 mile west of bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W), Calhoun County, Florida.

Etymology of the name: nana (Latin) – a dwarf; + *issimus* (superlative), for the small size of the species.

Occurrence: Chipola Formation, Florida.

Figured specimens: Fig. 2, USNM 482023 (holotype). Fig. 3, USNM 482024 (paratype A); height 7.0 mm, diameter 3.5 mm; locality TU 825. Fig. 4, USNM 482025 (paratype B); height 6.6 mm, diameter 3.3 mm; locality TU 825. Fig. 5, USNM 482026 (paratype C); height 5.2 mm, diameter 3.0 mm; locality TU 825. Additional localities: TU 459, 548, 555, 818-827, 999, 1048, 1049.

Discussion: This small species (maximum height under 10 mm) is found throughout the eastern portion of the Chipola Formation, although the bulk of the specimens occur in the calcarenite facies along Farley Creek. Placement in the genus *Murexsul* is somewhat problematic. The early whorls have the typical laminar varices of the genus (see pl. 8, fig. 5) but then as the shell grows larger these disappear and are replaced by rounded axial ridges. The early and later whorls are so different in appearance that they look like different species, but in an adult shell with well-preserved juvenile whorls (pl. 8, fig. 2) the change can be seen.

There is some resemblance to members of the subgenus *Muricopsis (Risomurex)* but the apertural denticles are not at all similar. Thus, this strange form is placed in *Murexsul*. There is no other species with which it may be compared and none with which it might be confused.

MUREXSUL MIMICUS Vokes
Plate 8, figure 6

Murexsul mimicus VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 70, pl. 8, fig. 5.

Description: "Shell with seven teleoconch whorls and a protoconch of one-and-one-half smooth, bulbous whorls. Spiral ornamentation beginning with three small cords on earliest post-nuclear whorls, one at the shoulder, one just posterior to the suture, and a third between these. The three continue, with that at the shoulder becoming strongest, and with numerous smaller threads intercalated, up to the body whorl. On body whorl, spiral ornamentation of four orders of magnitude: four major cords, three as above, plus one at base of body whorl; between each pair of major cords, sets of alternating larger and smaller intermediate threads; same pattern continued on siphonal canal. Axial ornamentation on earliest whorls of nine or 10 narrow flange-like varices, decreasing to six on each adult whorl; the later varices consisting of multiple laminae, forming short spines where the four major spiral cords cross, that at the shoulder slightly larger. In addition, surface shagreened by intersection of spiral threads and numerous axial growth lines. Aperture ovate, inner lip smooth, slightly appressed at posterior end, free-standing at anterior end; inner side of outer lip with five or six weak elongate denticles. Siphonal canal moderately long, narrow, slightly recurved at distal end, former terminations of canal forming a slight umbilicus." (Vokes, 1989)

Holotype: USNM 365145; height 20.1 mm, diameter 11.5 mm.

Type locality: TU 1215, Gurabo Formation; Río Gurabo, bluffs on both sides from the ford on the Los Quemados-Sabaneta road, upstream to approximately 1 km above the ford, Dominican Republic.

Occurrence: Gurabo Formation, Dominican Republic.

Figured specimen: USNM 365145 (holotype).

Discussion: Species such as *M. mimicus* cause difficulties in distinguishing between *Murexsul* and *Muricopsis*. There is a very strong resemblance between *M. mimicus* and the sympatric *Muricopsis praepauxilla;* however, the latter is an atypical member of the genus *Muricopsis*, with the body whorl more distinctly demarcated from the siphonal canal than in the typically biconic shell of most species of *Muricopsis*.

Known only from a single coral-reef locality in the Gurabo Formation, this species is most closely related to the slightly younger *M. thalmanni*, from the Agueguexquite Formation, Mexico. From the latter, *M. mimicus* differs in having a more inflated body whorl and a larger size.

MUREXSUL THALMANNI (Vokes)
Plate 8, figure 7

Hexaplex (Murexsul) thalmanni VOKES, 1968, Tulane Stud. Geol., v. 6, no. 3, p. 106, pl. 3, fig. 2.

Description: "Nuclear whorls unknown [one and one-half smooth whorls]; six post-nuclear whorls in holotype. Spiral sculpture on early

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PLATE 8

Figures — Page

1. *Murexsul* species 81
   (X 10) USNM 482022; height 5.5 mm, diameter 3.8 mm.
   Locality: TU 87, Butler, Alabama. Bashi Marl.

2-5. (?)*Murexsul nanissimus* Vokes, n. sp 81
   2. (X 6) USNM 482023 (holotype); height 8.6 mm, diameter 4.5 mm.
   3. (X 8) USNM 482024 (paratype A); height 7.0 mm, diameter 3.5 mm.
   4. (X 8) USNM 482025 (paratype B); height 6.6 mm, diameter 3.3 mm.
   5. (X 8) USNM 482026 (paratype C); height 5.2 mm, diameter 3.0 mm.
   Locality of all: TU 825, Farley Creek, Florida. Chipola Formation.

6. *Murexsul mimicus* Vokes 81
   (X 2 1/2) USNM 365145 (holotype); height 20.1 mm, diameter 11.5 mm.
   Locality: TU 1215, Río Gurabo, Dominican Republic. Gurabo Formation.

7. *Murexsul thalmanni* (Vokes) 82
   (X 3) USNM 482027; height 16.4 mm, diameter 8.9 mm.
   Locality: TU 1046, Veracruz, Mexico. Agueguexquite Formation.

8, 9. *Murexsul comptulus* Vokes, n. sp 84
   8. (X 5) USNM 482028 (holotype); height 10.7 mm, diameter 5.5 mm.
   Locality: TU 558, Crescent Beach, South Carolina. Waccamaw Formation.
   9. (X 10) USNM 482029 (paratype); height 9.4 mm, diameter 4.3 mm.
   Locality: same as holotype.

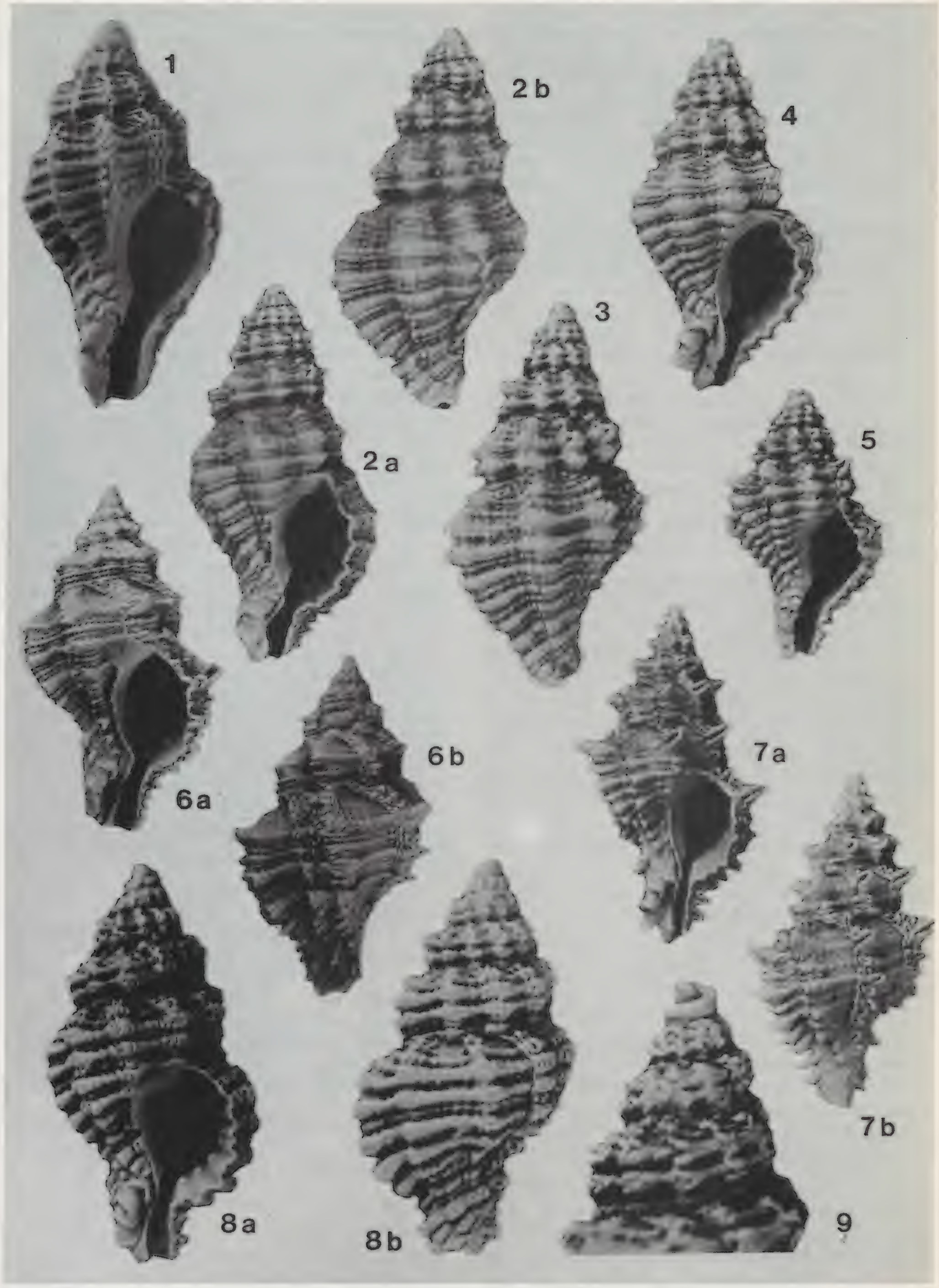

PLATE 8

whorls consisting of three equal ribs; on body whorl three primary ribs and between each pair of these a weaker secondary thread. Between the suture and the primary rib at the shoulder two secondary threads; between the anteriormost rib and the pillar also two secondary threads. Where the three primary ribs cross the varices small spines are produced, that at the shoulder only slightly larger than the others. Axial sculpture of eight varices on the penultimate whorl and six varices on the body whorl; varices composed of multiple laminae. Between the varices numerous axial growth lines, giving a shagreened texture to the shell surface. Aperture small, oval; columellar wall smooth. Siphonal canal short, recurved." (Vokes, 1968)

Holotype: USNM 645890; height 13.5 mm, diameter 6.0 mm.

Type locality: TU 638, Agueguexquite Formation; Mexico Highway 180, 14 miles [28 km] east of junction with side road into Coatzacoalcos, Veracruz, Mexico.

Occurrence: Agueguexquite Formation, Mexico.

Figured specimen: USNM 482027; height 16.4 mm, diameter 8.9 mm; locality TU 1046.

Discussion: When this species was described (Vokes, 1968), I believed that *Murexsul* was more closely related to the genus *Hexaplex* than it actually is. Subsequent work on the radula by Radwin and D'Attilio showed that the genus *Murexsul,* along with *Muricopsis, Murexiella* and others, differed from the Muricinae in the nature of the radula and they proposed the new subfamily Muricopsinae (1971, p. 64, fig. 21, radula of *Murexiella radwini,* showing the three-dimensional rachidian tooth). Thus, it is clear that the resemblance to *Hexaplex* is the result of parallel evolution.

At the time of the original description of *M. thalmanni,* the Agueguexquite Formation was correlated with the Choctawhatchee Formation (now Group) of northern Florida, and both were considered Late Miocene in age. The correlation is still considered correct, but both units are now dated as Middle Pliocene (N. 20). In the original type lot there were only four, rather battered, specimens all from the type locality. Since then we have collected several more examples but only one (the specimen figured in pl. 8, fig. 7) is better than the holotype. Most are lacking the whorls of the spire and as this damage is so consistent one wonders if there was not some predator (a crab, perhaps) that bit off the tops of these shells.

MUREXSUL COMPTULUS Vokes, n. sp.
Plate 8, figures 8, 9

Description: Holotype with five teleoconch whorls (probably six in fully adult shell); tabulate protoconch of one and one-half smooth whorls, with a marked keel beginning at posterior edge and gradually moving to mid-point of whorl by termination of protoconch. Change to teleoconch marked only by onset of spiral and axial ornamentation. Spiral ornamentation initially of one strong cord at mid-point, resulting from continuation of protoconch keel, with a second strong cord at shoulder; one weaker cord adjacent to anterior suture and another on shoulder ramp. With increasing whorls, a second weak cord added on shoulder ramp, resulting in five cords on penultimate whorl. An additional three strong cords on body whorl, for a total of six strong cords, separated at mid-point by one weak cord, with a second weak cord on shoulder ramp. Two weak cords in space between base of body whorl and siphonal canal, the latter with two additional strong cords. Axial ornamentation of about ten lamellar varices on all early whorls, decreasing to seven on fifth teleoconch whorl. With increasing size, varices formed of multiple laminae, giving rise to elaborately filigreed, but non-spinose, varices. Between varices entire surface shagreened by intersection of growth lamellae and spiral cords. Suture impressed. Aperture rounded, inner lip smooth, appressed along entire length. On inner side of outer lip six small denticles, anterior to shoulder cord. Margin of outer lip scalloped by spiral cords and somewhat patulous in anterior half. Siphonal canal short, broad, recurved at distal end.

Holotype: USNM 482028; height 10.7 mm, diameter 5.5 mm.

Type locality: TU 558, Waccamaw Formation; borrow pits at north end of Crescent Beach Airport, Crescent Beach, Horry County, South Carolina.

Etymology of name: comptulus (Latin) – ornamented (diminutive), in reference to surface ornamentation.

Occurrence: Waccamaw Formation, South Carolina.

Figured specimens: Fig. 8, USNM 482028 (holotype). Fig. 9, USNM 482029 (paratype); height 9.4 mm, diameter 4.3 mm; locality TU 558.

Discussion: From the beds of the Waccamaw Formation at Crescent Beach, South Carolina, we have two specimens (holotype and paratype) of a new species that cannot be compared with any New

World form. However, it is remarkably similar to the Recent Australian *Murexsul planiliratus* (Reeve, 1845), even to the strange keeled protoconch, which is most reminiscent of that normally seen in species of *Risomurex*. Both are relatively small species, an example of the Australian shell with only five teleoconch whorls is approximately the same size as the American one; the addition of a sixth teleoconch whorl to the Australian shell gives a height of about 17 mm, which is probably the size of a fully adult specimen of *M. comptulus*. Likewise, the overall outline of the shells is nearly the same at five whorls; the addition of a sixth whorl makes the Australian shell appear much more rotund. We do not know what the addition of one more whorl would do to the American shell.

The difference between the two species is primarily in the pattern of spiral cords, which in the Australian species are 15 in number (on the body whorl) and all of the same strength, in contrast to the pattern of (from posterior to anterior) one weak, three strong, one weak, three strong, two weak, two strong (total 12) seen in the American species. D'Attilio and Myers (1986, figs. 14-16) have given excellent illustrations of the protoconch and ornamentation in *M. planiliratus*. How these two disjunct species are related is a mystery. Presumably both go back to some unrecognized Eocene ancestor.

The surface ornamentation generated by the axial growth lines, leading to a series of overlapping scallops on each spiral cord, superficially resembles species of *Coralliophila*, but the protoconch (see pl. 8, fig. 9) indicates that the species is a member of the Muricopsinae.

Murexsul harasewychi Petuch
Plate 9, figures 1, 2

Murexsul harasewychi PETUCH, 1987, New Caribbean Moll. Faunas, p. 100, pl. 21, figs. 11, 12; PETUCH, 1988, Neogene Hist. Trop. Amer. Moll., p. 156, pl. 34, fig. 16 (holotype); KAICHER, 1991, Card Catalogue Worldwide Shells, pack 59, Muricidae – Part VI, no. 6075 (holotype).

Description: "Shell small for genus, thin, fragile, very elongated and fusiform, with high elevated spire; siphonal canal long, roughly one-third total length; 6 varices per whorl, shoulder sharply angled; body whorl sculptured with 5 large, fimbriated cords; area between suture and shoulder without large cords but with numerous fine spiral threads; shoulder of each varix with 1 small, bifurcated spine; 5 spiral cords overlap onto varices, producing low, fimbriated knobs; varices on siphonal canal with 2 short spines; aperture round-oval, with raised peristome; inner edge of lip without denticles; shell color two-toned, with body whorl and spire being yellow-orange and with siphonal canal being brown; early whorls, protoconch, and tips of shoulder spines pale reddish-brown; interior of aperture and peristome white." (Petuch, 1987)

Holotype: USNM 859845; height 14.7 mm, diameter 7.7 mm.

Type locality: Off Cabo de La Vela, Guajira Peninsula, Colombia, 35 meters.

Occurrence: Moín Formation, Costa Rica; Recent, northern South America.

Figured specimens: Fig. 1, USNM 859845 (holotype). Fig. 2, USNM 482030; height 13.6 mm, diameter 7.4 mm; locality TU 1240.

Discussion: Named from the living fauna off northern South America; there is a single specimen of *M. harasewychi* from the Moín Formation, Costa Rica.

Murexsul amphilogos Vokes, n. sp.
Plate 9, figure 3

Description: Shell with seven teleoconch whorls and a protoconch of one and one-half smooth, bulbous whorls, ending at a small recurved varix. Spiral ornamentation on first teleoconch whorl of two narrow cords, one at midpoint and one immediately adjacent to anterior suture. By third teleoconch whorl a third strong cord appearing at shoulder, plus intercalary threads between the three major spiral cords. On body whorl five major cords, with a small thread between each pair, two smaller cords in area between base of body whorl and siphonal canal, and on the latter another two strong cords. Axial ornamentation of eight laminar varices on all early whorls, decreasing to six on adult body whorl. Shoulder marked by long, sharp, open spines; on body whorl other major cords also marked by spines, that one immediately anterior to shoulder spine and that one at base of body whorl slightly smaller than the other three. With increasing size, varices becoming multiple layers of shell material, elaborately frilled by intersection of spiral cords and threads. Shell surface between varices shagreened by intersection of numerous growth lamellae and spiral ornamentation; especially on shoulder ramp with several threads made visible only by scalloping of growth lamellae. Suture impressed, crossed by growth lamellae. Aperture elongate-oval; inner lip smooth, free-

standing in anterior portion, appressed in posterior portion. Inner side of outer lip with about eight faint denticles. Siphonal canal long, recurved at distal end.

Holotype: USNM 482031; height 20.3 mm, diameter 10.4 mm.

Type locality: TU 1239, Moín Formation; hill cut above Standard Fruit Co. box factory at Pueblo Nuevo (same as TU 954 but stratigraphically about 15 meters higher – above the coral horizon), about 2 km west of Puerto Limon, Costa Rica.

Etymology of name: amphilogos (Greek) – questionable, doubtful.

Occurrence: Moín Formation, Costa Rica.

Figured specimen: USNM 482031 (holotype).

Discussion: Placement of this new species in the genus *Murexsul* is certainly a compromise, once again raising doubt about the generic distinctness of *Muricopsis* and *Murexsul*. The resemblance to some specimens of *Muricopsis oxytata* is striking. And yet, the nature of the aperture, with only weak denticles on the inner side of the outer lip and a completely smooth columellar lip indicates placement in *Murexsul*.

This choice is further strengthened by the fact that the species to which *M. amphilogos* bears the strongest resemblance is the New Zealand type species of the genus, *M. octogonus* (Quoy and Gaimard, 1833). In that species there are five major spiral cords, alternating with five secondary cords. In many specimens the difference in strength between the primary and secondary cords is so little as to give the appearance of ten equal cords, but other specimens have the two sets well differentiated (compare Radwin and D'Attilio, 1976, pl. 26, fig. 7 [the ten equal cords form] and fig. 6 [the five strong cords form]). It is the latter specimens that have the strongest resemblance to the Costa Rican species, which has five strong cords alternating with very faint secondary threads. The major difference between the two species is the size: *M. amphilogos* is about half the size of *M. octogonus*, with seven whorls in a shell of 20 mm height; a New Zealand shell with seven whorls measures over 40 mm in height.

MUREXSUL EMIPOWLUSI (Abbott)
Plate 9, figures 4, 5

Ocenebra (Ocinebrina) emipowlusi ABBOTT, 1954, Nautilus, v. 68, no. 2, p. 41, pl. 2, fig. 3; ABBOTT, 1974, Amer. Seashells (ed. 2), p. 184, fig. 1924.

?*Ocinebrina emipowlusi* (Abbott). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 126, pl. 21, fig. 9, text-fig. 77 (protoconch).

Ocenebra emipowlusi Abbott. FAIR, 1976, The Murex Book, p. 40, pl. 21, fig. 317 (holotype).

Murexsul emipowlusi (Abbott). VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 214.

Murexsul (or *Muricopsis*?) *emipowlusi* (Abbott). SUNDERLAND and SUNDERLAND, 1993, Amer. Conchologist, v. 21, no. 4, p. 14, text-fig.

PLATE 9

Figures — Page

1, 2. *Murexsul harasewychi* Petuch 85
1. (X 4) USNM 859845 (holotype); height 14.7 mm, diameter 7.7 mm.
Locality: off Guajira Peninsula, Colombia. Recent.
2. (X 4) USNM 482030; height 13.6 mm, diameter 7.4 mm.
Locality: TU 1240, Los Corales, Costa Rica. Moín Formation.

3. *Murexsul amphilogos* Vokes, n. sp 85
(X 3) USNM 482031 (holotype); height 20.3 mm, diameter 10.4 mm.
Locality: TU 1239, Pueblo Nuevo, Costa Rica. Moín Formation.

4, 5. *Murexsul emipowlusi* (Abbott) 86
4. (X 6) USNM 880011; height 6.8 mm, diameter 3.9 mm.
Locality: TU 977, Mississippi River Delta, Louisiana. Holocene.
5. (X 6) USNM 880012; height 9.0 mm, diameter 5.1 mm.
Locality: off Egmont Pass, Florida. Recent.

6. *Murexsul* species 88
(X 9) MNHN; height 5.2 mm, diameter 3.2 mm.
Locality: R/V *Marion-Dufresne* Station DC 35, off Vitória, Espírito Santo, Brazil. Recent.
(Photographs courtesy of R. Houart)

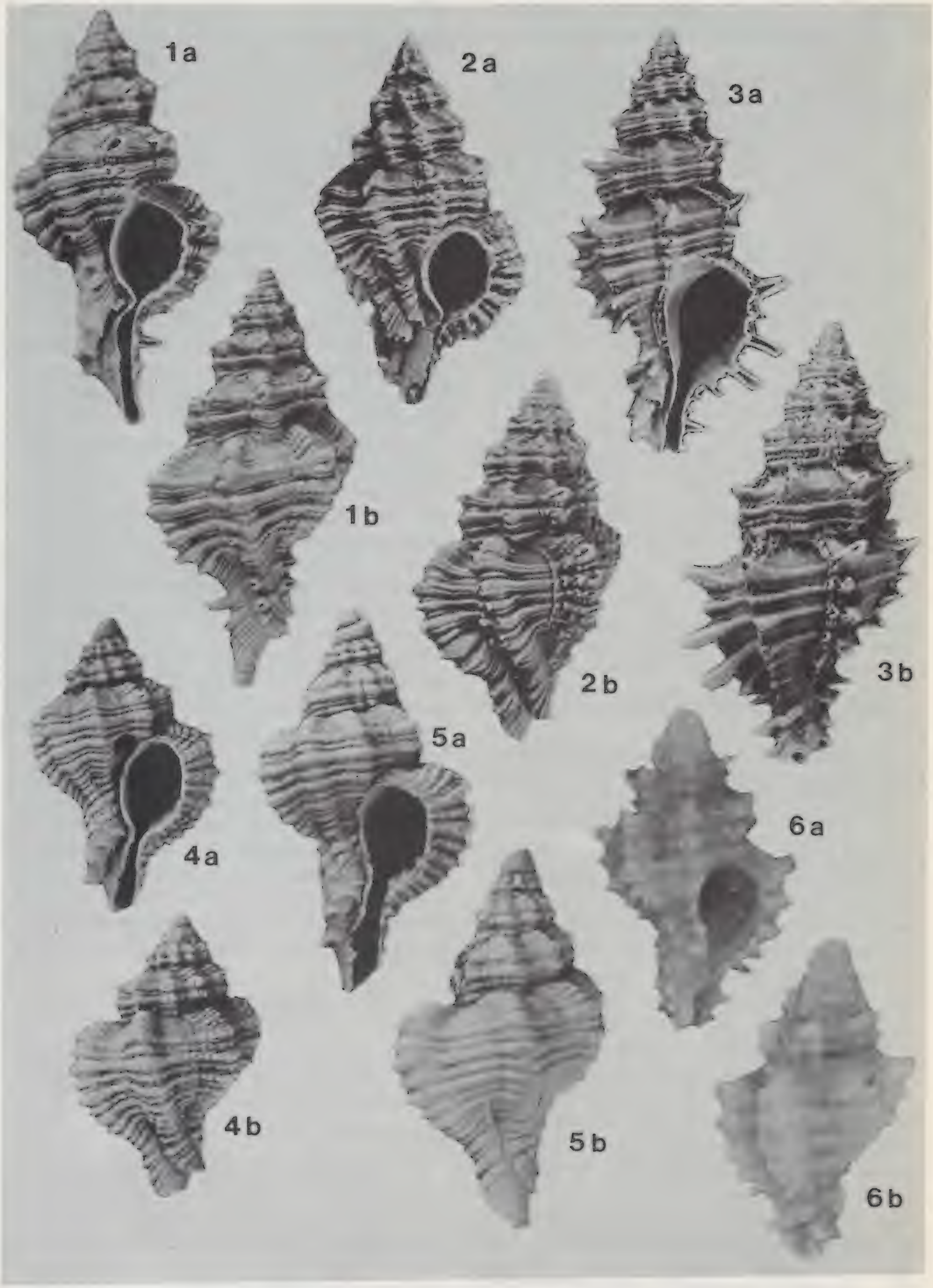

PLATE 9

[?] *Favartia* (?) sp. SUNDERLAND and SUNDERLAND, 1993, Amer. Conchologist, v. 21, no. 4, p. 15, text-fig.

Description: "Small, from 7 to 8 mm in length, broadly fusiform, and somewhat resembling a *Favartia;* color white throughout; 3 1/2 post-nuclear whorls; last whorl with 6 rounded axial, varix-like ribs; penultimate whorl with 7 to 8 similar ribs; the spiral sculpture consists of strongly raised, squarish, slightly fimbriated cords of which there are 17 to 20 on the last whorl, and 4 to 7 showing on the apical whorls. The one [and one-half] nuclear whorl is pronounced, glossy-white and bearing on the first half turn a strong, smooth spiral, carina, which gives the nucleus an obliquely carinate appearance; last half or third of nucleus without the carina [see Radwin and D'Attilio, 1976, text-fig. 77], and succeeded abruptly by the well-sculptured post-nuclear whorls. Aperture oval, almost complete and somewhat spout-like, with a thin, sharp inner and outer lip. No anal fasciole present. Inside of outer lip with 5 or 6 weak, elongate, glossy-white teeth of spiral origin. Outer lip slightly crenulate. Siphonal canal well developed, and almost closed along its length, except for a narrow slit. To its left are the ends of 3 or 4 earlier siphonal canals which overlap each other, one inserted in the other. Operculum horny, light-brown, oval, narrowed at the siphonal end, and ungulate in structure." (Abbott, 1954)

Holotype: USNM 613881; height 8.0 mm, diameter 5.0 mm.

Type locality: Dredged 90 miles [145 km] west of Fort Myers, Florida, in (?)90 fathoms [165 meters]; rubble bottom.

Occurrence: Holocene, Louisiana; Recent, Gulf of Mexico.

Figured specimens: Fig. 4, USNM 880011; height 6.8 mm, diameter 3.9 mm; locality TU 977. Fig. 5, USNM 880012; height 9.0 mm, diameter 5.1 mm; locality, off Egmont Pass, Hillsborough County, Florida, (?)220 meters.

Discussion: This small species (maximum height under 10 mm) is most similar to the more recently described *Murexsul harasewychi* Petuch, differing from the latter in having weaker spiral ornamentation.

Although apparently confined to the Gulf of Mexico, it is not rare there. In the Vokes Collection there are dozens of specimens, from dredgings made by James Moore, Bradenton, Florida, in the 1960's. The depth of dredging varied from about 50 to 120 meters, with the majority of the specimens from about 60 meters depth. The species is common in the Holocene fauna of locality TU 977, "Mud-Lump 90," at the mouth of the Mississippi River. The depositional depth of these beds has been estimated, based on foraminifera, at about 60 meters (Morgan *et al.*, 1963, p. 41).

The type locality of this species was stated to be 90 miles west of Fort Myers, Florida, in 90 fathoms (Abbott, 1954, p. 42). In addition, there were three paratypes in the Steger Collection (now in my collection), said to be from the same locality. In the Steger Collection there is another lot of six specimens, stated to be from west of Egmont Pass, in 120-130 fathoms (one figured here, pl. 9, fig. 5). Examination of a bathymetric map (*e.g.*, AAPG, 1970, Bathymetric Maps, Eastern Continental USA) shows that these depth figures are unreliable. At 90 miles west of Fort Myers, the depth is approximately 35 fathoms [64 meters]. The closest depth of 90 fathoms [165 meters] to Fort Myers is about 130 miles to the west (the 100 fathom line is approximately 140 miles west of Fort Myers). Depths of 120-130 fathoms would place the Steger lot about 110 miles west of Egmont Pass. Therefore, it seems likely that these recorded depths were measured in *feet* not fathoms, and that the actual depth at the type locality is 90 feet or 27 meters. The specimen on plate 9, figure 5, then would have come from 120-130 *feet* or 37-40 meters depth.

Sunderland and Sunderland (1993, p. 15, text-fig) have illustrated as *Favartia* sp., a specimen from the Moore dredgings off Egmont Key. Except for the elongate siphonal canal the shell is identical to examples of *M. emipowlusi,* and on the basis of this single specimen, it is assumed to be a pathologic example.

MUREXSUL species
Plate 9, figure 6

Muricopsis (?Murexsul) species HOUART, 1991, Nautilus, v. 105, no. 1, p. 31, text-figs. 8 (protoconch), 30, 31 (shell).

Occurrence: Recent only, off southeastern Brazil.

Figured specimen: MNHN; height 5.2 mm, diameter 3.2 mm; locality, R/V *Marion-Dufresne* Station DC 35, Jaseur Bank, off Vitória, Espírito Santo, Brazil, 82-105 meters (photographs courtesy of R. Houart).

Discussion: Houart (1991, p. 31, text-figs. 30, 31; refigured here pl. 9, fig. 6) has fi-

gured a juvenile specimen (maximum size 5.2 mm) of what may be a new species of *Murexsul*. As he noted, adult material must be collected before this species can be described.

Genus ACANTHOTROPHON Hertlein and Strong, 1951

Acanthotrophon HERTLEIN and STRONG, 1951, Zoologica, v. 36, pt. 5, p. 86.

Type species: *Trophon (Acanthotrophon) sorenseni* Hertlein and Strong, 1951, by original designation.

Discussion: *Acanthotrophon* originally was proposed as a subgenus of *Trophon* but in 1978 Radwin and D'Attilio demonstrated that the radula indicates placement in the subfamily Muricopsinae. Although the type species does resemble the typically unornamented species of the trophonine genus *Pagodula* Monterosato, 1884 (type species: *Murex vaginatus* Cristofori and Jan, 1832), most of the other species assigned to *Acanthotrophon* have more strongly ornamented shells and their resemblance to the genus *Murexsul* is more pronounced.

This genus is found principally along the coast of tropical western America from the Gulf of California to Ecuador. Due to confusion with superficially similar species of the muricine genus *Attiliosa* Emerson, 1968, the muricopsine genus *Acanthotrophon* was not recognized in the western Atlantic until Radwin and D'Attilio's work (1978) when two species were placed into this genus, namely *A. striatus* and a misidentified younger species, previously included in *A. striatus*, but later named *A. striatoides* Vokes, 1980.

ACANTHOTROPHON STRIATUS (Gabb) Plate 10, figure 1

Muricidea striata GABB, 1873, Amer. Phil. Soc., Trans., (N.S.), v. 15, p. 203; PILSBRY, 1922, Acad. Nat. Sci. Phila., Proc., v. 73, p. 354, pl. 28, fig. 7 (holotype).

Attiliosa striata (Gabb). VOKES, 1976, Tulane Stud. Geol. Paleont., v. 12, no. 3, p. 111 (in part, Dominican Republic references only), pl. 7, fig. 1 only (figs. 2-9 = *A. striatoides* Vokes), text-fig. 2 (holotype).

Acanthotrophon striatus (Gabb). RADWIN and D'ATTILIO, 1978, Tulane Stud. Geol. Paleont., v. 14, no. 3, p. 132 (in part, not figs. 1, 1a, 2 = *A. striatoides);* VOKES, 1980, Veliger, v. 23, no. 1, p. 10, text-figs. 1 (holotype), 2; VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 72, pl. 6, figs. 6-8.

Not *Attiliosa striata* (Gabb). KAICHER, 1979, Catalogue World-wide Shells, pack 20, Muricidae – Part IV, no. 2005; SUNDERLAND and SUNDERLAND, 1993, Amer. Conchologist, v. 21, no. 4, p. 15, text-fig. [= *A. striatoides* Vokes].

Description: "Spire elevated about equal to the aperture; whorls eight, including the nucleus; angulated. Body whorl sloping nearly straight above, convex below, the angle constricted in advance. Surface ornamented by seven large ribs on the widest part of the whorls, which become obsolete above and below. Crossing these below the angle are half a dozen linear ribs with broad smooth interspaces. These latter ribs are well developed where they cross the others, but are much smaller in the concave spaces. Mouth subovate, constricted in advance. Incrustation of the inner lip heavy, smooth, and with a projecting free edge; outer lip faintly striate internally. Canal twisted, with a broad imperforate umbilicus." (Gabb, 1873)

Holotype: ANSP 3249; height 12.3 mm, diameter 7.0 mm.

Type locality: TU 1227A, Gurabo Formation; Arroyo Zalaya, which crosses the road from Jánico to Santiago de los Caballeros, 11 km south of the bridge over the Río Yaque del Norte at Santiago, Dominican Republic (restricted by Vokes, 1989, p. 73).

Occurrence: Gurabo Formation, Dominican Republic.

Figured specimen: USNM 323898; height 14.2 mm, diameter 12.5 mm (including spines); locality TU 1215. Additional localities: TU 1210, 1211, 1219, 1227A, 1292, 1296, 1453A.

Discussion: When I treated the species *Muricidea striata* Gabb (Vokes, 1976, p. 111) only the single holotype specimen was known. Since that time, we have collected many more specimens of Gabb's species in the Dominican Republic. My original placement in the muricine genus *Attiliosa* is not correct, nor is the inclusion in this species of younger specimens from fossil and Recent localities throughout the Gulf of Mexico region. Beautifully preserved examples from Costa Rica, referable to the same species as these latter specimens, demonstrated that they are distinct. In 1980, this form was designated *Acanthotrophon striatoides* Vokes.

True *Acanthotrophon striatus*, which is confined to the Early Pliocene Gurabo Formation of the Dominican Republic, differs from the younger *A. striatoides* in

being smaller (our largest specimen is no more than 15 mm in height) and more inflated.

ACANTHOTROPHON STRIATOIDES Vokes
Plate 10, figures 2-4

Muricidea philippiana DALL, 1889, Harvard Mus. Comp. Zool., Bull., v. 18, p. 213 (in part, references to Key West specimen only).

Coralliophila philippiana (Dall). M. SMITH, 1939, Illus. Cat. Recent Species Rock Shells, p. 33, pl. 20, fig. 20 (Dall's Key West specimen) (SMITH, 1953, *ibid.*).

Attiliosa philippiana (Dall). S. HOERLE, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 2, p. 63; RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 26, pl. 3, fig. 10; KAICHER, 1980, Catalogue World-wide Shells, pack 25, Muricidae – Part V, no. 2005/2574 (of Dall, in part only).

Poirieria pazi (Crosse). RIOS, 1975, Brazilian Marine Moll. Icon., p. 86, pl. 24, fig. 350 (*not* of Crosse).

Attiliosa striata (Gabb). VOKES, 1976, Tulane Stud. Geol. Paleont., v. 12, no. 3, p. 111 (in part), pl. 7, figs. 2-9, pl. 8, figs. 1-8; KAICHER, 1979, Catalogue World-wide Shells, pack 20, Muricidae – Part IV, no. 2005; SUNDERLAND and SUNDERLAND, 1993, Amer. Conchologist, v. 21, no. 4, p. 15, text-fig. (*not* of Gabb).

Acanthotrophon striatus (Gabb). RADWIN and D'ATTILIO, 1978, Tulane Stud. Geol. Paleont., v. 14, no. 3, p. 131, text-figs. 1, 2 (*not* of Gabb).

Acanthotrophon striatoides VOKES, 1980, Veliger, v. 23, no. 1, p. 13, text-figs. 3-9 [note that figures 6 and 7 are reversed; the explanation for fig. 6 refers to fig. 7, and *vice versa*]; KAICHER, 1980, Catalogue World-wide Shells, pack 25, Muricidae -- Part V, no. 2569; VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 214, pl. 2, fig. 18.

Description: "Seven post-nuclear whorls in adult, plus a protoconch of 2 1/2 bulbous turns. Spiral ornamentation beginning abruptly with 2 small sharp cords, most pronounced on first 2 whorls, gradually fading to become a single faint ridge connecting shoulder spines. On body whorl from 3 to 7 cords, with usually 3 of these stronger, separated by a space from another cord at base of body-whorl, usually very strong (but not always); an additional 1 or 2 smaller cords on the extended siphonal canal. Axial ornamentation beginning with 7 to 9 small nodes, gradually becoming spinose varices with sharp spines where spiral cords cross these varices, their strength relative to that of the cord, shoulder spine always the longest. Surface scabrous; in some, where the axial growth lines cross the spiral cords, smaller spinelets. Suture undulating, subsutural ramp unornamented except for faint recurved growth lines reflecting the anal notch. Aperture oval, outer lip flaring at posterior end and bearing within about 8 lirations. Inner lip appressed at posterior end, standing free at anterior end; smooth except for a series of small denticles of variable number, strength, and shape, at extreme anterior end. Siphonal canal moderately long, slightly recurved at distal end; moderate to large umbilical opening formed by series of previous terminations of the canal." (Vokes, 1980)

Holotype: USNM 298656; height 21.3 mm, diameter 14.0 mm.

Type locality: TU 1240, Moín Formation; Barrio Los Corales, hilltop at end of road that passes

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PLATE 10

Figures Page

1. *Acanthotrophon striatus* (Gabb) 89
(X 3) USNM 323898; height 14.2 mm, diameter 12.5 mm (including spines).
Locality: TU 1215, Río Gurabo, Dominican Republic. Gurabo Formation.
2-4. *Acanthotrophon striatoides* Vokes 90
2. (X 2 1/2) USNM 298656 (holotype); height 21.3 mm, diameter 14.0 mm.
Locality: TU 1240, Los Corales, Costa Rica. Moín Formation.
3. (X 2) USNM 482032; height 26.9 mm, diameter 16.3 mm.
Locality: Capelleti Brothers Pits, Florida. Bermont Formation.
4. (X 2 1/2) USNM 880013; height 22.5 mm, diameter 12.5 mm.
Locality: Espírito Santo, Brazil. Recent.
5. *Acanthotrophon ascensus* (Vokes) 92
(X 4) USNM 482033; height 14.1 mm, diameter 7.7 mm.
Locality: TU 1240, Los Corales, Costa Rica. Moín Formation.
6. *Acanthotrophon* sp. cf. *A. ascensus* (Vokes) 93
(X 4) MCZ "7305;" height 14.0 mm, diameter 10.0 mm.
Locality: Unknown. Recent.

PLATE 10

Standard Fruit Company box factory, 1.8 km north of main highway at Pueblo Nuevo, which is 2 km west of Puerto Limón, Costa Rica.

Occurrence: Agueguexquite Formation, Veracruz, Mexico; Pinecrest Beds [= Fruitville Formation], Tamiami, Caloosahatchee, and Bermont formations, Florida; Moín Formation, Costa Rica; Recent, southern Florida to Brazil.

Figured specimens: Fig. 2, USNM 298656 (holotype). Fig. 3, USNM 482032; height 26.9 mm, diameter 16.3 mm; locality, Capelleti Brothers Pits, Dade County, Florida. Fig. 4, USNM 880013; height 22.5 mm, diameter 12.5 mm; locality, Guarapari Channel, Espírito Santo, Brazil. Additional localities: TU localities 201, 638, 726, 727, 759, 933, 954, 991, 1000, 1046, 1177, 1307, 1536.

Discussion: In my treatment of the muricine genus *Attiliosa* (Vokes, 1976), I figured several specimens as "*Attiliosa striata* (Gabb)." Only one specimen, the holotype of that species (1976, pl. 7, fig. 1), was correctly identified; *all* of the other specimens are a different species. Further, none (including *A. striata*) should be referred to *Attiliosa* but, as demonstrated by Radwin and D'Attilio (1978), to the muricopsine genus *Acanthotrophon*.

Therefore, in 1980, to correct these errors I reviewed the entire genus *Acanthotrophon*, which is predominantly from the eastern Pacific region. The misidentified "*A. striata*" were described as *A. striatoides*, with the type specimen from the Early Pleistocene Moín Formation of Costa Rica. This species is widespread in the fossil record, with examples from all of the Plio-Pleistocene formations of southern Florida, as well as the Pliocene Agueguexquite Formation of Mexico and the Moín Formation of Costa Rica. The species is still present in the western Atlantic, with most of the specimens collected from the southern end of Florida. However, Rios (1975, p. 86, pl. 24, fig. 350) has recorded the species (under the name *Poirieria pazi*) off northern Brazil, and several specimens have been taken at Guarapari, Espírito Santo, Brazil, that are referable to this species (pl. 10, fig. 4). Presumably this disjunct distribution today is a reflection of wider distribution during the Pleistocene, as witnessed by its presence in Costa Rica.

ACANTHOTROPHON ASCENSUS (Vokes)
Plate 10, figure 5

Calotrophon ascensus VOKES, 1976, Tulane Stud. Geol. Paleont., v. 12, no. 3, p. 110, pl. 6, figs. 1, 2.

Description: "Shell small, with a protoconch of one and one-half bulbous whorls; five teleoconch whorls in the type material (possibly six in adult specimens). Early ornamentation consisting of ten or eleven small loop-like spines on the first two post-nuclear whorls, decreasing to seven or eight on later whorls. Spiral ornamentation not visible except on body whorl, where three major cords encicle the central portion of the whorl, with two minor cords between the anteriormost major cord and the constriction into the siphonal canal. Only a single poorly developed cord on the siphonal canal. Spiral cords made scabrous by small axial growth lines, and also where the spirals cross the varices, especially on the apertural side of each varix. Suture impressed, subsutural area almost perpendicular to the suture, giving a stepped appearance to the spire, which is greatly extended relative to the entire shell. Spire about one-half the total length of the shell. Aperture oval, outer edge crenulated by the three strong spiral cords; inner side of outer lip bearing five or six lirations. Inner lip smooth, polished, appressed against the columellar wall. Siphonal canal short, recurved at the distal end, forming a small fasciole. Shell probably covered in life by a heavy intritacalx, only fragments preserved on fossil specimens." (Vokes, 1976)

Holotype: USNM 240679; height 14.7 mm, diameter 8.7 mm.

Type locality: TU 954, Moín Formation; hill cut immediately behind Standard Fruit Company box factory, just west of cemetery at Pueblo Nuevo, about 2 km west of Puerto Limón, Costa Rica.

Occurrence: Moín Formation, Costa Rica.

Figured specimen: USNM 482033; height 14.1 mm, diameter 7.7 mm; locality TU 1240.

Discussion: The placement of this small species is a puzzle. Originally I placed it in the genus *Calotrophon*, because of its similarity to the living form *C. andrewsi* Vokes, 1976. At that time the genus *Acanthotrophon* had not yet been recognized in the western Atlantic. With recognition of the presence of *Acanthotrophon* in the area came realization that this muricopsine genus is a better place for the Costa Rican species. This assignment is strongly influenced by the discovery of a species, identified here as *Acanthotrophon* sp. cf. *A. ascensus*, which closely resembles *A. ascensus*. Only examination of living specimens of these two puzzling forms can establish the correct generic assignment.

ACANTHOTROPHON sp. cf. A. ASCENSUS
(Vokes)
Plate 10, figure 6

Occurrence: Recent only, unknown locality, presumably Caribbean Sea.

Figured specimen: MCZ "7305;" height 14.0 mm, diameter 10.0 mm; locality unknown.

Discussion: As noted in the previous part of this series (Vokes, 1992, p. 50) the specimen in the box supposedly containing the holotype of *Poirieria (Panamurex) carnicolor* (Clench and Pérez Farfante, 1945) is not that specimen, nor even the same genus. Search of the molluscan collections in the Museum of Comparative Zoology, Harvard University, did not locate the misplaced holotype, so we are presented with two questions – what has become of the holotype of *P. (P.) carnicolor* and where did the specimen shown here (pl. 10, fig. 6) actually come from.

This mystery specimen is placed in the genus *Acanthotrophon,* although lacking a complete aperture makes this somewhat dubious. Without an entire specimen and no locality, there is no justification for describing the species, but it is figured here to call attention to this form, hoping that someone will recognize specimens in other collections.

Genus MUREXIELLA Clench and
Pérez Farfante, 1945

Subgenus MUREXIELLA s.s.

Murexiella CLENCH and PÉREZ FARFANTE, 1945, Johnsonia, v. 1, no. 17, p. 49.

Type species: *Murex hidalgoi* Crosse, 1869, by original designation.

Minnimurex WOOLACOTT, 1957, Roy. Soc. New South Wales, Proc., (1955-1956), p. 115.

Type species: *Minnimurex phantom* Woolacott, 1957, by original designation.

Discussion: The genus *Murexiella* was treated previously together with the superficially similar muricine genus *Hexaplex* in Part IV of this series (Vokes, 1968, p. 106). Only subsequently did work on the radulae indicate that the similarities – approximately six foliate varices in both – are the result of convergence rather than close relationship. The principal conchological difference, which becomes more obvious when the radular differences are recognized, is the nature of the aperture, with an almost entire, rounded aperture in *Murexiella,* as opposed to *Hexaplex* in which the outer lip opens into the varical spines.

Certain authors (Ponder, 1972; Houart, 1991) have suggested that *Murexiella* should be placed in synonymy with the closely related genus *Favartia* Jousseaume, 1880. This is a comfortable solution to the placement of certain Indo-Pacific species that do not fit unequivocally into one genus or the other. Even in the western Atlantic there are species that are problematical, such as *Favartia barbarae,* n. sp. (see below).

Nevertheless, the reasons for not making this move are to me more compelling. Foremost, is the fact that *Murexiella* is geologically older. If it were possible to place *Favartia* in synonymy with *Murexiella,* I would agree, for the latter certainly is derived from the former. But the rules of nomenclature do not permit this. In addition, I consider *Subpterynotus* to be allied with *Murexiella,* and subgeneric status seems desirable. However, I would have difficulty placing *Subpterynotus* within the genus *Favartia.*

Morphologically, although the type species of *Murexiella* and *Favartia* differ greatly, other species are more similar. In general, *Favartia* is a "chunky" shell, with varices comprised of rounded ridges, and the digitations do not extend beyond the edge of the ridge. The siphonal canal is short and, in some species, even tubular. In general, the height of the spire is equal to, or even greater than, the length of the siphonal canal. Conversely, in *Murexiella* the varices are elaborately spinose, with long recurved processes extending past the varical webbing in many species. The siphonal canal is elongate and commonly decorated with two or three rows of spines.

The genus *Murexiella* extends back to the early Paleogene geologic record with species that are little different from those still living today. As a result, the genus is world-wide tropical and all of the species are "maddenly" similar. All have a variable number of varices, ranging from four to eight in any given species; and most have brownish color bands circling the subsutural region and the base of the body whorl.

On both the Atlantic and Pacific sides of tropical America the species may be divided into three groups: the typical form with very long straight spines; those with recurved spines, including members of the *M. macgintyi* complex; and those with short, straight spines, including members of the *M. glypta* complex.

Although there is almost no fossil record from the eastern Pacific [with the exception of *Murexiella lappa* (Broderip, 1833), known from the Early Pliocene Esmeraldas Beds; see Vokes, 1988, p. 37] there are 13 living species. It is curious that most of the species from the eastern Pacific, for which the protoconch is known, have multiwhorl protoconchs (from two and one-half to three and one-half whorls). Conversely, in the western Atlantic, most of the species, excluding *M. levicula* and *M. puntagordanum,* have the more "advanced" protoconch of one and one half whorls. The implications, in terms of phylogenetic relationships, are totally conjectural and we may be seeing no more than an ultimate example of parallelism.*

In an earlier study (Vokes, 1968), two species were referred to *Murexiella* that I now refer to *Homalocantha.* These are *"Murex" crispangula* Heilprin, 1886, and *Murexiella calhounensis* Vokes, 1968, from the Late Oligocene and Early Miocene fossil record, respectively. They are treated below with that genus.

Most species of *Murexiella* were discussed at length in this same work and much of the information given previously will not be repeated. The reader is referred there for additional data. For those species treated systematically in Part IV (Vokes, 1968) only abbreviated synonymies are included.

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*Previously (Vokes, 1984), I have given a list of supposed cognate species, but since that time a number of new species have been named and other taxa have been redefined. Specifically, what I named in 1970 as *Murexiella keenae* has been determined to be true *M. humilis,* and what I believed to be *M. humilis* is *M. norrisi* (Reeve) (see D'Attilio and Myers, 1987). The holotype of *Murex minuscula* Smith, 1947, now in the collections of the Florida State Museum of Natural History, is only an unusual color variant of *Murexiella lappa* (Broderip, 1833). The type of *Murex radicatus* Hinds, 1845, is the same species as *Murex exiguus* Broderip, 1833.

Murexiella (Murexiella) mantelli (Conrad)
Plate 11, figure 1

Murex mantelli CONRAD, 1834, Acad. Nat. Sci. Phila., Jour., v. 7, p. 154; CONRAD, 1865, Amer. Jour. Conch., v. 1, no. 3, p. 210, pl. 20, fig. 11.

Murex conradi D'ORBIGNY, 1850, Prodrome Paléontologie, v. 2, p. 364. Unnecessary new name for *Murex mantelli* Conrad.

Murex (Phyllonotus, Sect. *Favartia) mantelli* Conrad. PALMER, 1937, Bulls. Amer. Paleontology, v. 7, no. 32, p. 269, pl. 35, figs. 13, 15-17; pl. 84, fig. 10 (holotype).

Murexiella (Murexiella) mantelli (Conrad). VOKES, 1968, Tulane Stud. Geol., v. 6, no. 3, p. 107, pl. 5, fig. 1 (holotype).

Description: "Shell subfusiform, body whorl inflated; with six angular varices, crossed by prominent equidistant lines, expanding on the varices, and terminating in very short, foliated, obtuse spines; between the lines is a fine stria; fine longitudinal striae passing over the spiral lines; spire short; aperture ovate; channel nearly closed; beak larger than the spire, reflected." (Conrad, 1834)

Holotype: ANSP 14231; height 26.0 mm, diameter 19.0 mm.

Type locality: Gosport Sand; Claiborne Bluff, Alabama River, Monroe County, Alabama (= TU 78).

Occurrence: Gosport Sand, Alabama.

Figured specimen: ANSP 14231 (holotype). Additional locality: TU 78.

Discussion: This species remains rare and known only from the type locality. As noted earlier (Vokes, 1968, p. 107), *M. mantelli* is surprisingly similar to living species of the genus.

Murexiella (Murexiella) vaughani MacNeil *in* MacNeil and Dockery
Plate 11, figure 2

Murexiella (Murexiella) sp. VOKES, 1968, Tulane Stud. Geol., v. 6, no. 3, p. 107, pl. 5, fig. 2.

Murexiella (Murexiella) vaughani. MACNEIL *in* MACNEIL and DOCKERY, 1984, Mississippi Dept. Nat. Res., Bur. Geol., Bull. 124, p. 124, pl. 5, fig. 9.

Description: "Shell small, spire moderately low; spire whorls made bicarinate by two heavy straight sided spiral ribs, body whorl with four spiral ribs, ribs with median cleft; varices moderately flaring, back side entire, front side with a bundle of about six frilled growth lamellae, each progressively lower but not noticeably down-curved; shoulder with a moderately strong upward projecting hollow spine; inner lip

narrowly attached to parietal wall, detached below; canal set at a moderate angle; no umbilicus but with a weak chink.

"The protoconch is not well preserved, but it appears to consist of about two whorls and to form a short, narrow, slightly tilted cone." (MacNeil and Dockery, 1984)

Holotype: USNM 498089; height (incomplete) 10.8 mm, diameter 8.0 mm.

Type locality: USGS 5263, Red Bluff Formation; Chickasawhay River, one mile below Shubuta, Wayne County, Mississippi (= TU 1288).

Occurrence: Red Bluff Formation, Mississippi.

Figured specimen: USGS 498089 (holotype). Additional locality: TU 226.

Discussion: *Murexiella vaughani,* named from the type locality of the Red Bluff Formation by MacNeil and Dockery (1984, p. 124), is the first species to show the median groove in the spiral cords, which becomes so characteristic of later species of the genus.

MUREXIELLA (MUREXIELLA) SHILOHENSIS (Heilprin)
Plate 11, figure 3

Murex shilohensis HEILPRIN, 1888, Acad. Nat. Sci. Phila., Proc., v. 39, p. 404; WHITFIELD, 1894, U.S. Geol. Surv., Mon. 24, p. 97, pl. 17, fig. 1 (holotype).

Muricidea shilohensis (Heilprin). MARTIN, 1904, Maryland Geol. Surv., Miocene, p. 202, pl. 51, figs. 4-6; RICHARDS and HARBISON, 1942, Acad. Nat. Sci. Phila., Proc., v. 94, p. 211, pl. 19, fig. 11 (holotype).

Murexiella (Murexiella) shilohensis (Heilprin). VOKES, 1968, Tulane Stud. Geol., v. 6, no. 3, p. 110, pl. 6, figs. 3 (holotype), 4 (not fig. 2 = *M. parvula,* n. sp.).

Murexiella shilohensis (Heilprin). PETUCH, 1993, Nautilus, v. 106, no. 4, p. 170.

Description: "Whorls about seven, angular, flattened on the shoulder, which is crossed diagonally by the variceal ridges; varices about eight on the body-whorl, sub-equal, spinosely elevated on the shoulder angulation, and crossed by four sub-equal revolving ridges, which appear double on the crests of the varices; only two such ridges on the whorls above the body-whorl.

"Aperture somewhat more than half the length of the shell, key-hole shaped, with the canal broadly deflected." (Heilprin, 1888)

Holotype: ANSP 4081; height 18 mm, diameter 10 mm.

Type locality: Kirkwood Formation; Ayres' pits, near Shiloh, Cumberland County, New Jersey.

Occurrence: Kirkwood Formation, New Jersey; Calvert Formation, Maryland; Pinecrest Beds [= Fruitville Formation], Jackson Bluff Formation, Caloosahatchee Formation, Florida; Waccamaw Formation, South Carolina.

Figured specimen: Stephens Collection; height 18.7 mm, diameter 9.3 mm; locality TU 991. Additional localities: TU 60, 79, 200, 202, 203, 519, 520, 525, 527, 539B, 558, 726, 728, 729, 736, 753, 755, 767, 768, 770, 797, 933, 1000, 1044, 1493, 1512, 1524, 1536.

Discussion: This species was described from the marl pits at Shiloh, New Jersey. An effort was made to re-collect this famous locality but today the pits are long abandoned and small ponds mark the region where the marl pits were once located. No shell material is visible anywhere in the area.

The beds at Shiloh have been considered to be of Middle Miocene age but, in a recent paper, Sugarman *et al.* (1993) date the shell bed ("Shiloh Marl") that crops out in the Kirkwood Formation at approximately 20 million years. This would make the fauna of Early Burdigalian age, in contrast to the Chipola Formation, which is considered to be approximately 16 ma, or Late Burdigalian in age.

Although rare in the more northern portions of the Atlantic Coastal Plain, *M. shilohensis* is widespread in the Plio-Pleistocene of Florida and South Carolina. It occurs in some numbers in the Pinecrest Beds [= Fruitville Formation] of southern Florida, especially at localities TU 729 and TU 1000. It also is abundant in the Jackson Bluff Formation (TU 60) of northern Florida. It is less common in the Caloosahatchee Formation, although the figured specimen (pl. 11, fig. 3), the largest specimen seen, is from that unit. It also occurs in the correlative Waccamaw Formation of South Carolina (TU 558). But, it is not recorded from the Bermont Formation nor does it occur in the Recent fauna of the western Atlantic.

The type specimen of *M. shilohensis* is poorly preserved but there seems little question it is the same as the more common occurrences in southern Florida. If *M. shilohensis* was an inhabitant of cooler water, this would account for its presence in the Jackson Bluff and Pinecrest formations in southern Florida – but this does not explain its presence in some numbers in the more tropical Caloosahatchee and

Waccamaw formations. Perhaps the species was able to change its ecologic requirements through time.

As noted in the original discussion (Vokes, 1968, p. 112) of *M. shilohensis*, there is a similar form in the Chipola Formation. Much additional material of both the Chipola species and true *M. shilohensis* shows the two species to be distinct and the Chipola form is named *M. parvula* herein.

MUREXIELLA (MUREXIELLA) PARVULA
Vokes, n. sp.
Plate 11, figures 4, 5

Murexiella (Murexiella) shilohensis (Heilprin).
VOKES, 1968, Tulane Stud. Geol., v. 6, no. 3, p. 110 (in part, Chipola specimens only), pl. 6, fig. 2 only (*not* of Heilprin).

Description: Shell small (maximum height under 12 mm) with five teleoconch whorls and protoconch of one and one-half relatively large, smooth, bulbous whorls, ending at a small straight varix. Spiral ornamentation on first teleoconch whorl of a single cord placed near anterior suture; on second teleoconch whorl a second strong cord developed at shoulder. Two cords on all whorls up to body whorl, the latter with five strong cords and one additional cord on siphonal canal. Between major cords numerous faint spiral threads, made visible primarily by the scalloping of growth lamellae. Axial ornamentation on first teleoconch whorl of eight lamellar varices, lapping well onto the smooth protoconch. Subsequent whorls with from seven to nine varices on each, gradually becoming elaborately filigreed by multiple layers of shelly material, scalloped by spiral ornamenation. On the second teleoconch whorl strong, adapically-directed spines at intersection of shoulder cord and varices; a second weaker spine at intersection of sutural cord and varices. On body whorl long sharp, abaperturally-directed spines at each major cord, that at shoulder recurved apically as well. Suture impressed. Aperture ovate; inner lip smooth, freestanding in anterior portion, appressed in posterior portion; no anal notch. Inner side of outer lip smooth, margin crenulated by major spiral cords. Siphonal canal moderately long, strongly reflected, a series of spurs at former terminations, giving rise to a small fasciole.

Holotype: USNM 482034; height 9.8 mm, diameter 6.4 mm.

Type locality: TU 820, Chipola Formation; Farley Creek, at bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W), Calhoun County, Florida.

Etymology of name: parvulus (Latin) – little (diminutive).

Occurrence: Chipola Formation, Florida.

Figured specimens: Fig. 4, USNM 482034 (ho-

PLATE 11

Figures

1. *Murexiella (Murexiella) mantelli* (Conrad) 94
(X 2) ANSP 14231 (holotype); height 26.0 mm, diameter 19.0 mm.
Locality: Claiborne Bluff, Alabama (= TU 78). Gosport Sand.

2. *Murexiella (Murexiella) vaughani* MacNeil *in* MacNeil and Dockery 94
(X 4) USNM 498089 (holotype); height (incomplete) 10.8 mm, diameter 8.0 mm.
Locality: USGS 5263, Chickasawhay River, Mississippi (= TU 1288). Red Bluff Formation.

3. *Murexiella (Murexiella) shilohensis* (Heilprin) 95
(X 3) Stephens Collection; height 18.7 mm, diameter 9.3 mm.
Locality: TU 991, La Belle, Florida. Caloosahatchee Formation.

4, 5. *Murexiella (Murexiella) parvula* Vokes, n. sp 96
4. (X 5) USNM 482034 (holotype); height 9.8 mm, diameter 6.4 mm.
Locality: TU 820, Farley Creek, Florida. Chipola Formation.
5. (X 5) USNM 645892 (paratype); height 11.5 mm, diameter 7.5 mm.
Locality: TU 825, Farley Creek, Florida. Chipola Formation.

6-8. *Murexiella (Murexiella) hidalgoi* (Crosse) 102
6. (X 3) USNM 323900; height 18.3 mm, diameter 11.4 mm.
Locality: TU 1211, Río Gurabo, Dominican Republic. Gurabo Formation.
7. (X 3) USNM 482035; height 21.9 mm, diameter 13.5 mm.
Locality: TU 729, Kissimmee River, Florida. Pinecrest Beds.
8. (X 3) USNM 482036; height 18.7 mm, diameter 12.8 mm.
Locality: TU 1240, Los Corales, Costa Rica. Moín Formation.

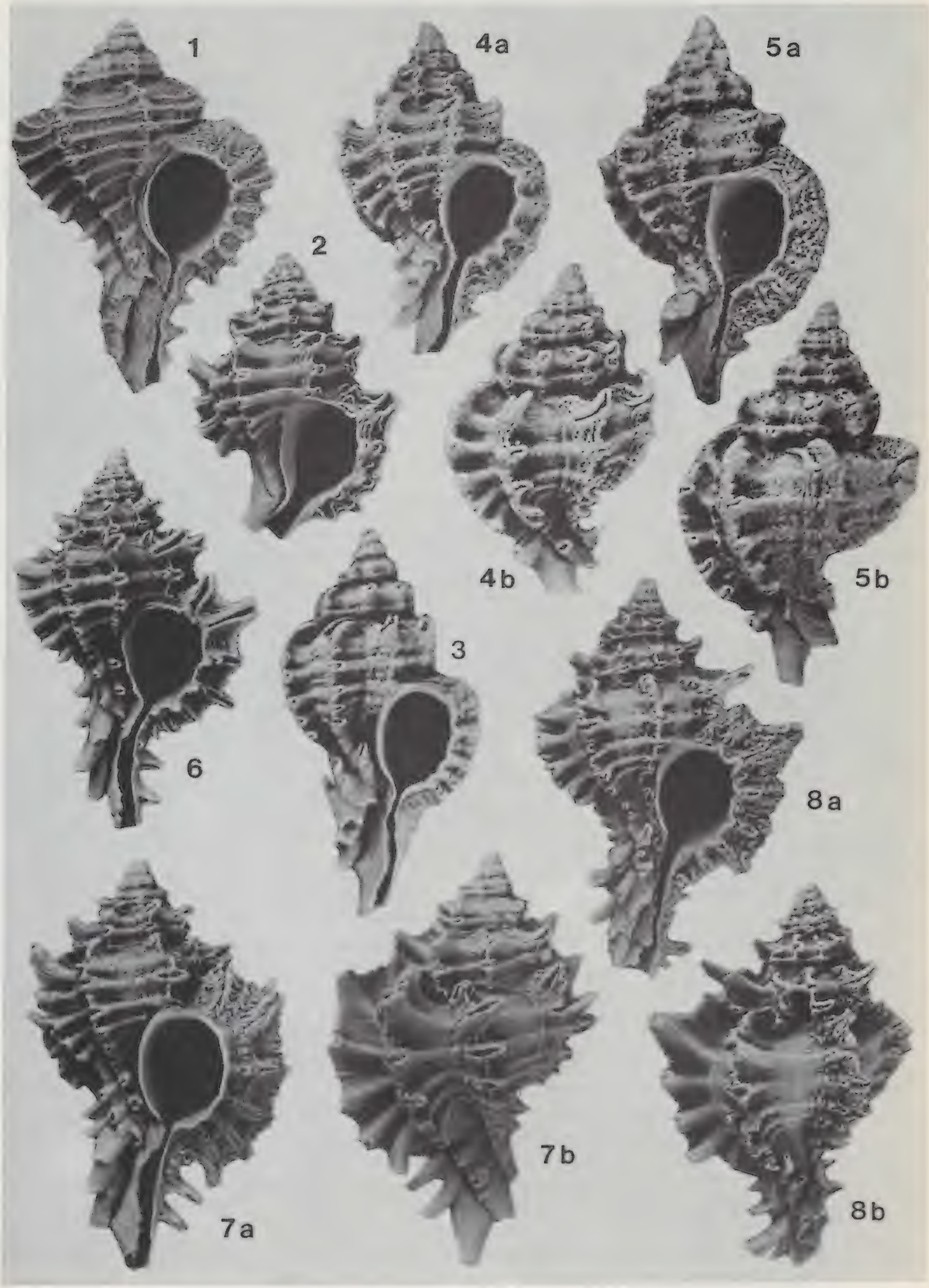

PLATE 11

lotype). Fig. 5, USNM 645892 (paratype); height 11.5 mm, diameter 7.5 mm; locality TU 825. Additional localities: TU 457, 458, 459, 546, 547, 548, 554, 555, 818-821, 824, 827, 950, 998, 999, 1048, 1049, 1196.

Discussion: As noted above, the Chipola specimen figured as *M. shilohensis* (Vokes, 1968, pl. 6, fig. 2) is not that species but is new and is named here; the previously figured shell is selected as a paratype of the new species. The holotype, although smaller, is better preserved. This new species differs from the similar *M. shilohensis* in being more inflated, with a shorter, more recurved siphonal canal. The siphonal canal has but a single spine on each varix, in contrast to the two spines of *M. shilohensis*.

From the lengthy list of localities (above), it is obvious that this species is widely distributed in the Chipola Formation; however, at most localities it is represented by only one or two specimens. Only at localities TU 819 and 825, on Farley Creek, and TU 554, on the Chipola River, are there any numbers of specimens. Clearly this species preferred the calcarenite facies of the Farley Creek area to the more silty facies found in the western part of the formation.

MUREXIELLA (MUREXIELLA) FACETA (Vokes)
Plate 12, figures 1-3

Murex shilohensis var. *burnsi* WHITFIELD, 1894 (post-March), U.S. Geol. Surv., Mon. 24, p. 98, pl. 17, fig. 2 (*non Murex burnsii* Aldrich, January, 1894).

Muricidea burnsi (Whitfield). RICHARDS and HARBISON, 1942, Acad. Nat. Sci. Phila., Proc., v. 94, p. 212, pl. 19, fig. 10 (holotype).

Murex (Murexiella) macgintyi facetus VOKES, 1963, Tulane Stud. Geol., v. 1, no. 4, p. 157, pl. 2, fig. 4.

Murexiella (Murexiella) macgintyi faceta (Vokes). VOKES, 1968, Tulane Stud. Geol., v. 6, no. 3, p. 113, pl. 7, figs. 1, 2.

Not *Murexiella fasciatus [sic]* (Vokes). SUNDERLAND and SUNDERLAND, 1992, Amer. Conchologist, v. 20, no. 3, p. 14, text-fig. [= *M. hilli* Petuch].

Description: "Shell moderate in size, body whorl greatly inflated. Nucleus of 1 1/2 smooth, rounded whorls; six post-nuclear whorls in the adult. Spiral sculpture consists of sharply raised ribs, two in number on the early whorls, five on the body whorl. Axial sculpture consists of five to seven varices; where the spiral ribs cross the varices long, recurved, foliaceous, open spines are produced. In addition, one spine is formed where no rib is present between the suture and the shoulder, and two spines are produced on the extended siphonal canal. The intervarical space is patterned with microscopic spiral lirae and growth lines which give a reticulate surface. The varices are formed of finely laminate layers, creating a complex webbing between the spines. Aperture sub-circular; labium completely free, erect, and smooth; the outer lip bearing six grooves corresponding to the varical spines.

PLATE 12

Figures Page

1-3. *Murexiella (Murexiella) faceta* (Vokes) 98
1. (X 2) USNM 644376 (holotype); height 24.0 mm, diameter 18.0 mm.
Locality: TU 520, Brighton, Florida. Pinecrest Beds.
2. (X 3) Stephens Collection; height 15.5 mm, diameter 11.2 mm.
Locality: TU 1000, Sarasota, Florida. Pinecrest Beds.
3. (X 8; protoconch X 10) USNM 482037; height 6.5 mm, diameter 5.5 mm.
Locality: TU 1000, Sarasota, Florida. Pinecrest Beds.

4-7. *Murexiella (Murexiella) edwardpauli* Petuch 113
4. (X 3) USNM 860529 (holotype); height 15.2 mm, diameter 9.3 mm.
Locality: off Portobelo, Panama. Recent.
5. (X 3) USNM 482038; height 18.0 mm, diameter 10.0 mm.
Locality: TU 1023, Pahokee, Florida. (?)Caloosahatchee Formation.
6. (X 3) USNM 482039; height 17.7 mm, diameter 10.8 mm.
Locality: TU 1046, Veracruz, Mexico. Agueguexquite Formation.
7. (X 3) USNM 482040; height 14.8 mm, diameter 8.7 mm.
Locality: TU 954, Pueblo Nuevo, Costa Rica. Moín Formation.

8. *Murexiella (Murexiella) graceae* (McGinty) 115
(X 2 1/2) USNM 482041; height 20.1 mm, diameter 14.3 mm.
Locality: TU 725, North New River Canal, Florida. Bermont Formation.

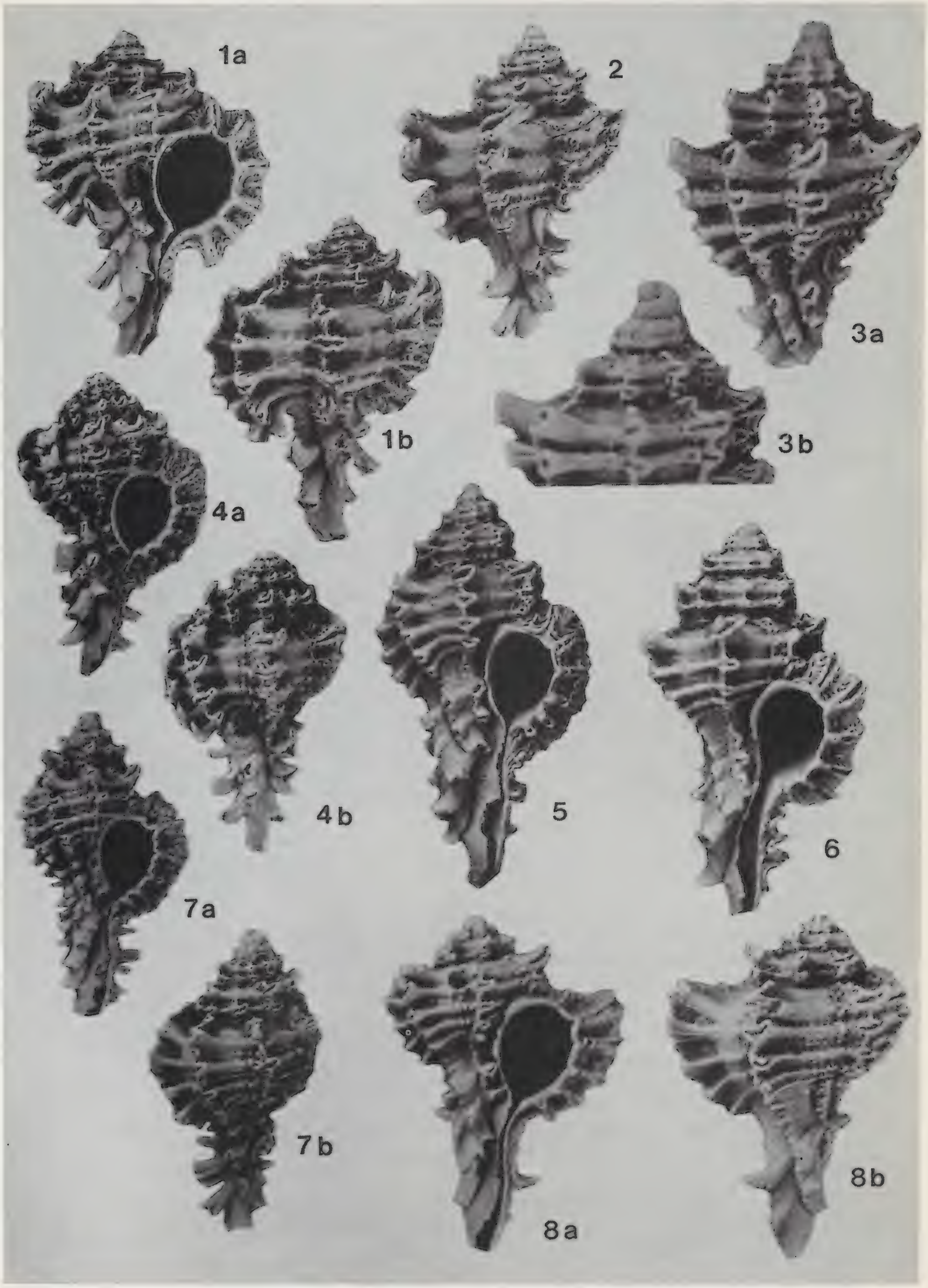

PLATE 12

Siphonal canal moderately long and recurved, the succession of previous canals forming an anterior fasciole." (Vokes, 1963)

Holotype: USNM 644376; height 24.0 mm, diameter 18.0 mm.

Type locality: TU 520, Pinecrest Beds [= Fruitville Formation]; canal 0.9 mile east of Brighton, Highlands County, Florida.

Occurrence: Kirkwood Formation, New Jersey; Duplin Formation, North Carolina; Jackson Bluff Formation, Pinecrest Beds [= Fruitville Formation]; Florida; Agueguexquite Formation, Veracruz, Mexico.

Figured specimens: Fig. 1, USNM 644376 (holotype). Fig. 2, Stephens Collection; height 15.5 mm, diameter 11.2 mm; locality TU 1000. Fig. 3, USNM 482037; height 6.5 mm, diameter 5.5 mm; locality TU 1000. Additional localities: TU 60, 200, 523, 525, 638, 729, 730, 736, 756, 796, 1493, 1524.

Discussion: As noted in the Dominican report (Vokes, 1989, p. 65), the presence of *Murexiella macgintyi* s.s. in the Late Miocene Cercado Formation indicates that the typical form of the species evolved in the more tropical waters of the Caribbean and moved into southern Florida only with the warmer waters of the Plio-Pleistocene Caloosahatchee Formation. In southern Florida during the earlier Pliocene the form present is that one named *M. macgintyi faceta* (Vokes), which differs in its more inflated body whorl and lower spire; the "pinched portion" between the body whorl and the siphonal canal is more extended, giving an elongated appearance to the shell.

Although named as a stratigraphic subspecies of *M. macgintyi,* this form equally could be considered a subspecies of *M. graceae* (McGinty), to which it is closely related. Recent work by Sugarman *et al.* (1993) indicates the age of the Kirkwood Formation (where *M. faceta* also occurs, as *Murex shilohensis* var. *burnsi* Whitfield, *non M. burnsii* Aldrich; see Vokes, 1963, p. 157) is Early Burdigalian, much older than previously believed. Therefore, it is possible that *M. faceta* is ancestral to both *M. macgintyi* and *M. graceae*. In any case, the subspecific designation is inappropriate.

The Recent species found in the Netherlands Antilles off the coast of northern South America has been referred to *M. faceta* but its correct designation is *Murexiella hilli* Petuch, 1987.

MUREXIELLA (MUREXIELLA) species
Plate 16, figure 9

Favartia sp. PERRILLIAT, 1972, Paleontología Mexicana, no. 32, p. 81, pl. 40, figs. 3, 4.

Occurrence: (?)Medias Aguas Formation, Veracruz, Mexico.

Figured specimen: USNM 645987; height 10.3 mm, diameter 6.4 mm; locality USGS 23737, Santa Rosa, Veracruz, Mexico.

Discussion: From the beds near Santa Rosa (now Istal), Veracruz, Mexico, there

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PLATE 13

Figures Page
1-3. *Murexiella (Murexiella) petuchi* Vokes, n. sp 106
1. (X 4) USNM 482042 (holotype); height 13.2 mm, diameter 8.2 mm.
Locality: TU 1000, Sarasota, Florida. Pinecrest Beds.
2. (X 4) USNM 482043 (paratype A); height 10.6 mm, diameter 6.4 mm.
Locality: same as holotype.
3. (X 10) USNM 482044 (paratype B); height 5.8 mm, diameter 3.7 mm.
Locality: same as holotype.
4, 5. *Murexiella (Murexiella) stephensae* Vokes, n. sp 107
4. (X 3) USNM 482045 (holotype); height 18.6 mm, diameter 11.3 mm.
Locality: TU 1493, Arvida Pit, Coral Gables, Florida. (?)Tamiami Formation.
5. (X 3) USNM 482046 (paratype); height 16.0 mm, diameter 9.9 mm.
Locality: same as holotype.
6. *Murexiella (Murexiella) hilli* Petuch 115
(X 1 1/2) USNM 838034; height 35.4 mm, diameter 22.8 mm.
Locality: Aruba, Netherlands Antilles. Recent.
7. *Murexiella (Murexiella) taylorae* Petuch 116
(X 2 1/2) USNM 838033; height 21.6 mm, diameter 14.8 mm.
Locality: off Cape San Blas, Florida. Recent.

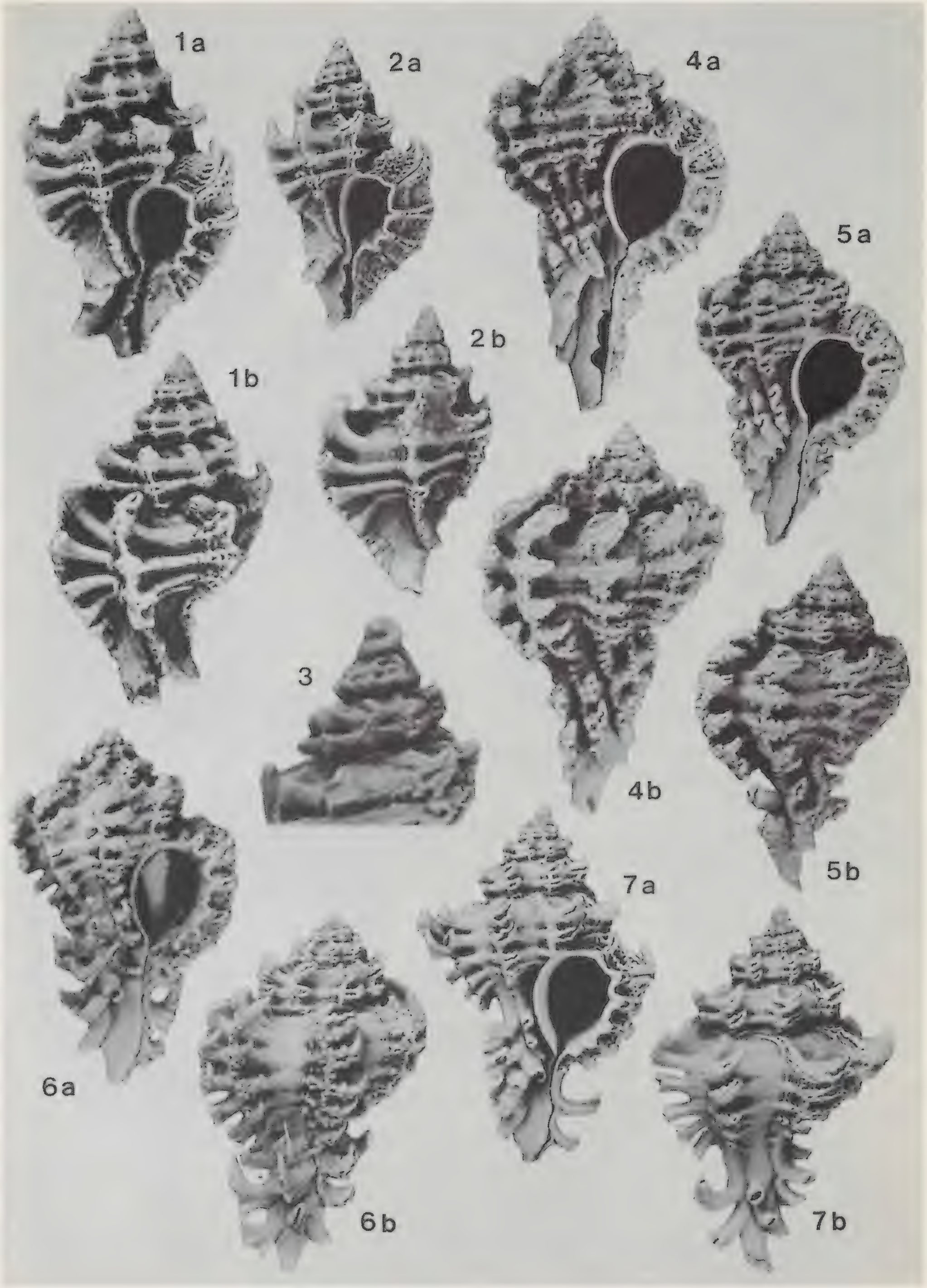

PLATE 13

is a single juvenile specimen that Perrilliat (1972, p. 81, pl. 40, figs. 3, 4) cited only as "*Favartia* sp." In the Dominican Republic report (Vokes, 1989, p. 64), I referred this specimen to *Murexiella hidalgoi* (Crosse). This assignment was based upon Perrilliat's illustration, but once I examined the actual specimen I realized this was incorrect. However, I cannot assign it to any other known species.

The species resembles *M. glypta,* but is smaller and the spiral cords are more flattened. It has a stronger resemblance to Recent examples of *M. glypta,* which tend to have the ribs more flattened than the older examples from the Caloosahatchee and Bermont formations, where the spiral cords are more elevated and scabrous than in the living representatives.

The age of the beds at Perrilliat's locality, stated to be 3 km northeast of Santa Rosa (now Istal), Veracruz, is not established, but nearby outcrops have been dated by Dr. W. H. Akers (personal communication, 1979) as Neogene Zone N. 17, and it is assumed that this specimen is from the same Medias Aguas Formation of Late Miocene age. [See below under *Favartia (Caribiella) carmenae,* n. sp., for further discussion of this unusual locality.]

As the sole example is a juvenile, this species will not be named, but it cannot be assigned to a described species and it is presumed to be new.

MUREXIELLA (MUREXIELLA) HIDALGOI
(Crosse)
Plate 11, figures 6-8

Murex hidalgoi CROSSE, 1869, Jour. de Conchyl., v. 17, p. 408; CROSSE, *ibid.*, v. 19, p. 68, pl. 1, fig. 4.

Murex (Murexiella) hidalgoi Crosse. CLENCH and PÉREZ FARFANTE, 1945, Johnsonia, v. 1, no. 17, p. 50, pl. 26, figs. 1-4; ABBOTT, 1954, Amer. Seashells, p. 203, text-fig. 45a; ABBOTT, 1974, Amer. Seashells (ed. 2), p. 174, text-fig. 1842.

Murexiella (Murexiella) hidalgoi (Crosse). VOKES, 1968, Tulane Stud. Geol., v. 6, no. 3, p. 119; VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 64, pl. 8, fig. 1.

Murexiella hidalgoi (Crosse). KAICHER, 1973, Card Catalogue World-wide Shells, pack 2, Muricidae – Part I, no. 135; RIOS, 1975, Brazilian Marine Moll. Icon., p. 86, pl. 24, fig. 352; RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 157, pl. 25, fig. 8, text-fig. 99 (radula); FAIR, 1976, The Murex Book, p. 48, pl. 19, fig. 266; ABBOTT and DANCE, 1982, Compendium Seashells, p. 143, color fig.; VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 212, pl. 2, fig. 2; RIOS, 1985, Seashells of Brazil, p. 85, pl. 30, fig. 374; SUNDERLAND and SUNDERLAND, 1992, Amer. Conchologist, v. 20, no. 3, p. 14, text-fig.

Favartia (Murexiella) hidalgoi (Crosse). HOUART, 1991, Nautilus, v. 105, no. 1, p. 32.

Description: "T. brevissime, parum crassa sed solidula, paululum translucida, unicolor, albida; spira sat elongata; sutura profunde impressa; anfr. 7 1/2-8 sexvaricosi, primi subangulati, vix aut non spinosi, antepenultimus et penultimus varicibus in spinas longiusculas, excavatas desinentibus instructi, costis 2 validis spiraliter muniti, ultimus spiram superans (::22:14), transversim costis 5 validis minutissime squamosis, versus marginem externum in spinas totidem desinentibus et costulis minoribus, in interstitiis sitis, separatis impressus, et spinis quin-

PLATE 14

Figures Page

1-7. *Murexiella (Murexiella) macgintyi* (Smith) 104

1. (X 3) USNM 482047; height 18.5 mm, diameter 12.9 mm.
   Locality: TU 1512, Arcadia, Floria. Caloosahatchee Formation.
2. (X 4) NMB H 17004; height 10.3 mm, diameter 6.3 mm.
   Locality: NMB 16842, Río Cana, Dominican Republic. Cercado Formation.
3. (X 4) NMB H 17467; height (incomplete) 12.1 mm, diameter 9.1 mm.
   Locality: NMB 17531, Punta Gavilán, Venezuela. Punta Gavilán Formation.
4. (X 2) Stephens Collection; height 25.5 mm, diameter 16.6 mm.
   Locality: TU 770, Kissimmee River, Florida. Caloosahatchee Formation.
5. (X 3) USNM 880014; height 16.3 mm, diameter 11.8 mm.
   Locality: Great Abaco Island, Bahama Islands. Recent.
6. (X 1 1/2) USNM 482048; height 37.4 mm, diameter 23.3 mm.
   Locality: TU 1536, Star Ranch Pit, Florida. Bermont Formation.
7. (X 1 1/2) USNM 880015; height 39.3 mm, diameter 26.4 mm.
   Locality: Salvador, Bahia, Brazil. Recent.

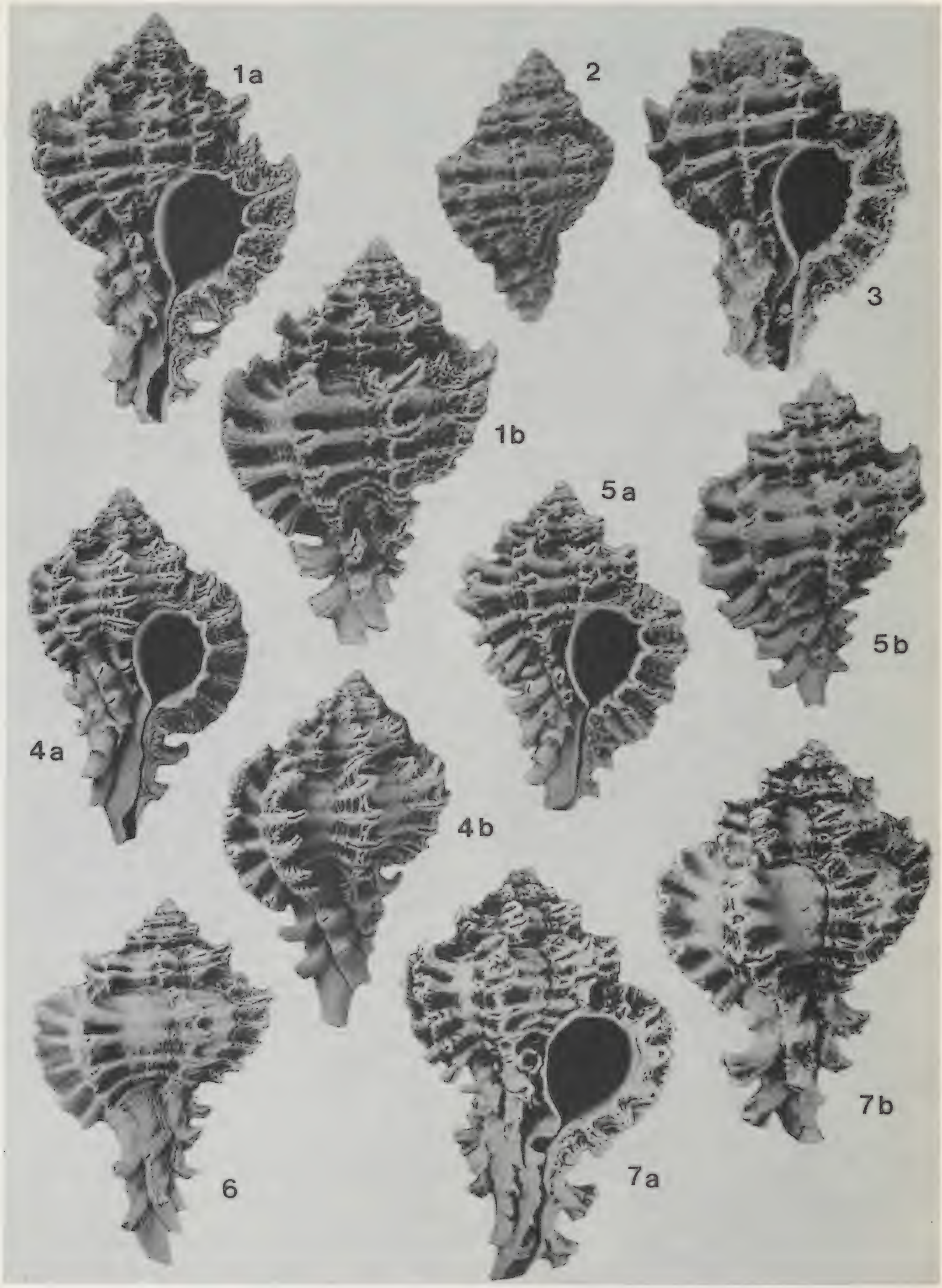

PLATE 14

queseriatim dispositis et varicibus correspondentibus ornatus, serie prima spinarum subincurva, majore, e costa suturae magis vicina oriunda; apertura ovata, parva, subintegra, intus laevigata, alba, in canalem longiusculum, fere clausum, subrecurvum, utrinque sat breviter spinosulum desinens; perist. albidum, subcontinuum, margine columellari laevigato, subarcuato, leviter prominulo, externo ad limbum subundoso, mox extus, occursu varicis, in alam aperturae latitudinem superantem, et in interstitiis spinarum lineis undosis elegantissime sculptam producto." (Crosse, 1869)

Holotype: Collection of Patricio Paz of Madrid (Clench and Pérez Farfante, 1945, p. 51), now in the Madrid Museum (Dance, 1966, p. 297); height 36 mm, diameter (including spines) 27 mm (*fide* Crosse, 1869, p. 409).

Type locality: Guadeloupe, Lesser Antilles (restricted by Clench and Pérez Farfante, 1945, p. 51).

Occurrence: Gurabo Formation, Dominican Republic; Pinecrest Beds [= Fruitville Formation], Florida; Moín Formation, Costa Rica; Recent, Gulf of Mexico to southern Brazil.

Figured specimens: Fig. 6, USNM 323900; height 18.3 mm, diameter 11.4 mm; locality TU 1211. Fig. 7, USNM 482035; height 21.9 mm, diameter 13.5 mm; locality TU 729. Fig. 8, USNM 482036; height 18.7 mm, diameter 12.8 mm; locality TU 1240. Additional localities: TU 954, 1219, 1240, 1277, 1307, 1412.

Discussion: Today *Murexiella hidalgoi* is restricted to moderately deep water, living at depths ranging from 140 to 360 meters (Clench and Pérez Farfante, 1945, p. 51), but most abundant at about 200 meters. This is contrary to the fossil occurrences, where the species has been taken in the shallower facies of the Gurabo Formation, Dominican Republic, the Pinecrest Beds [= Fruitville Formation] along the Kissimmee Canal (TU 729), and the Moín Formation, Costa Rica.

Although Radwin and D'Attilio (1976, p. 157) state that this species has a protoconch of two and one half whorls, all examples I have seen have the usual one and one half whorls. In some specimens. the external ornamentation decorticates from the early teleoconch whorls giving the impression of additional smooth nuclear whorls.

Murexiella (Murexiella) macgintyi (M. Smith)

Plate 14, figures 1-7

Murex macgintyi M. SMITH, 1938, Nautilus, v. 51, no. 3, p. 88, pl. 6, fig. 11.

Tritonalia mcgintyi [sic] (Smith). M. SMITH, 1939, Illus. Cat. Recent Species Rock Shells, p. 16, pl. 12, fig. 20 (SMITH, 1953, *ibid.*).

Murex (Favartia) macgintyi Smith. CLENCH and PÉREZ FARFANTE, 1945, Johnsonia, v. 1, no. 17, p. 52, pl. 27, figs. 1-4; OLSSON and HARBISON, 1953, Acad. Nat. Sci. Phila., Mon. 8, p. 246, pl. 36, fig. 5; RIOS, 1970, Coastal Brazilian Seashells, p. 79, pl. 22.

Murex cellulosus leviculus Dall. WARMKE and ABBOTT, 1961, Caribbean Seashells, p. 106, pl. 19h (*not* of Dall).

Murex (Murexiella) macgintyi Smith. VOKES, 1963, Tulane Stud. Geol., v. 1, no. 4, p. 157; ABBOTT, 1974, Amer. Seashells (ed. 2), p. 175, text-fig. 1846.

Murexiella (Murexiella) macgintyi (Smith). VOKES, 1968, Tulane Stud. Geol., v. 6, no. 3, p. 112, pl. 7, fig. 3 (holotype); VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 212, pl. 2, fig. 6; VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 64, pl. 8, fig. 11.

Not *Murexiella macgintyi* (Smith). KAICHER, 1973, Card Catalogue World-wide Shells, pack 2, Muricidae – Part I, no. 110 [= *M. hilli* Petuch].

Murexiella macgintyi (Smith). RIOS, 1975, Brazilian Marine Moll. Icon., p. 86, pl. 25, fig. 353; RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 159 (in part), pl. 25, fig. 11 (not fig. 10 = *M. taylorae* Petuch), text-fig. 100 (protoconch)); FAIR, 1976, The Murex Book, p. 55, pl. 20, fig. 278 (holotype, not *M. laurae* Vokes, as stated), not pl. 19, fig. 272 (= holotype *M. laurae*); ABBOTT and DANCE, 1982, Compendium Seashells, p. 143 (in part), not color fig. (= *M. hilli* Petuch); VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 212, pl. 2, fig. 6; RIOS, 1985, Seashells of Brazil, p. 85, pl. 30, fig. 375; [?] WARD and BLACKWELDER, 1987, Smithsonian Cont. Paleobiology, no. 61, p. 173, pl. 39, figs. 3, 4; DE JONG and COOMANS, 1988, Stud. Fauna Curaçao, Caribbean Islands, v. 49, p. 73 (in part, Aruba specimens = *M. hilli* Petuch); KAICHER, 1991, Card Catalogue World-wide Shells, pack 59, Muricidae – Part VI, no. 6077 (holotype).

Murex (Favartia) cellulosus Conrad. HUMFREY, 1975, Sea Shells of the West Indies, p. 136, pl. 16, fig. 4 (*not* of Conrad).

Murexiella leonardhilli PETUCH, 1987, New Caribbean Moll. Faunas, p. 141, pl. 28, figs. 5, 6; SUNDERLAND and SUNDERLAND, 1992, Amer. Conchologist, v. 20, no. 3, p. 14, text-fig.

Description: "Whorls five, plus smooth shining nucleus of about two [one and one-half] whorls, suture impressed; about seven spiral raised ridges with slightly branching terminations which are recurved, hollow inside near the

tips, aperture moderately large, oval in shape; canal slightly oblique, partially closed, recurved at terminus.

"This species is allied to *M. glyptus* Smith. One very characteristic feature is the pinched appearance of the posterior portion of the body whorl. Beyond this pinched portion is a pair of axial ridges which are somewhat separated from the others." (Smith, 1938)

Holotype: UF 28981; height 20.7 mm, diameter 18.0 mm.

Type locality: Caloosahatchee Formation; Clewiston, Hendry County, Florida.

Occurrence: Cercado and Gurabo formations, Dominican Republic; Punta Gavilán Formation, Venezuela; Caloosahatchee and (?)Bermont formations, Florida; Waccamaw Formation, South Carolina; (?)James City Formation, North Carolina; Recent, Bahama Islands to Brazil.

Figured specimens: Fig. 1, USNM 482047; height 18.5 mm, diameter 12.9 mm; locality TU 1512. Fig. 2, NMB H 17004; height 10.3 mm, diameter 4.3 mm; locality NMB 16842. Fig. 3, NMB H 17467; height 12.1 mm (incomplete), diameter 9.1 mm; locality NMB 17531. Fig. 4, Stephens Collection; height 25.5 mm, diameter 16.6 mm; locality TU 770. Fig. 5, USNM 880014, height 16.3 mm, diameter 11.8 mm; locality, Elbow Cay, Great Abaco Island, Bahama Islands. Fig. 6, USNM 482048; height 37.4 mm, diameter 23.3 mm; locality TU 1536. Fig. 7, USNM 880015; height 39.3 mm, diameter 26.4 mm, locality, Salvador, Bahia, Brazil, 20 meters. Additional localities: TU 68, 79, 202, 203, 519, 523, 527, 528, 529B, 536, 539B, 541, 558, 579, 726, 753, 767, 768, 770, 797, 870, 982, 991, 1227A, 1230, 1358.

Discussion: Described from the Late Pliocene-Early Pleistocene Caloosahatchee Formation of southern Florida, *Murexiella macgintyi* is found living today in calcareous localities from the Bahamas to Brazil. There are a number of similar members of the genus that have been confused with *M. macgintyi* in the literature. Among these is the larger and more massive *M. hilli* Petuch, which lives along the northern coast of South America; the smaller, more widely shouldered *M. taylorae* Petuch, which is confined to the western coast of Florida; and the more elongate *M. edwardpauli* Petuch, described from the Atlantic coast of Panama but also present in older beds of Florida, Mexico, and Costa Rica.

The form of this species found along the coast of Brazil from Pará to Bahia has been named *M. leonardhilli* Petuch (1987, p. 141, pl. 28, figs. 5, 6) but other than larger size, there is little reason to separate this southern occurrence as a geographic subspecies. The only discernible difference between the southern specimens and the northern *M. macgintyi,* which is found from the Bahamas to Cuba and the Virgin Islands, is the presence in the Brazilian form of a small spine in the "pinched portion" of the varices between the body whorl and the siphonal canal. Typical *M. macgintyi* from the Caloosahatchee Formation has a marked "pinched portion" but in some Recent examples from the Bahamas (pl. 14, fig. 5) and Florida, a small spine is present in this area. In the Brazilian specimens this spine is more prominent. Compared with the similarities, these differences are insignificant and the two forms are synonymous.

True *M. macgintyi* occurs in the Late Miocene-Early Pliocene Cercado and Gurabo formations of the Dominican Republic (Vokes, 1989, p. 64, pl. 8, fig. 11; refigured here pl. 14, fig. 2) but it does not appear in Florida until the Late Pliocene. In the earlier beds of the Pinecrest Beds [= Fruitville Formation] the form present is the larger, more inflated *M. faceta* (Vokes), which also occurs in the Agueguexquite Formation of Mexico. This may be a reflection of cooler water in the Gulf of Mexico prior to the closing of the Isthmus of Panama. I assume that *M. macgintyi* evolved in the more tropical portions of the Caribbean and moved into Florida only when the temperature increased in the Late Pliocene. In the collections of the Naturhistorisches Museum, Basel, there are are several examples of typical *M. macgintyi,* from the Punta Gavilán Formation of Venezuela (pl. 14, fig. 3), correlative with the Pinecrest and Agueguexquite formations.

Although *M. macgintyi* occurs both living and in the Caloosahatchee Formation, we have not taken a single specimen from the Bermont Formation. But one specimen has been collected by Mr. John Waldrop, at locality TU 1536 (Star Ranch Pit, 11 miles south of South Bay, Palm Beach County, Florida), which appears to be the largest known fossil example of *M. macgintyi* (pl. 14, fig. 6).

At Star Ranch the pit has reached deeper beds than other pits in the area (*e.g.*, localities TU 727, 751) and the majority of the spoil at this site can be referred to

the Caloosahatchee Formation or to the Pinecrest Beds. But there is a moderate amount of Bermont material also. The fossils from these three units may be separated by the "whiter" color of the Bermont specimens, in contrast to a more creamy color of the Caloosahatchee and Pinecrest fossils.

When collecting, by the color one can easily determine which unit was reached by the particular dragline. Mr. Waldrop states that the specimen figured here is from the Bermont Formation; the pure white color corroborates that claim. This extraordinarily large specimen is not a typical Caloosahatchee example of *M. macgintyi*. Normally, they are no more than 25 mm in height (a single specimen from locality TU 991, in the collection of Mrs. Susan Stephens, measures 36 mm). This shell, presumably from the Bermont, is similar to the large Brazilian form named *M. leonardhilli* Petuch (pl. 14, fig. 7).

Ward and Blackwelder (1987, p. 173, pl. 39, figs. 3, 4) have figured a specimen from the James City Formation at the Lee Creek Mine, North Carolina, as *Murexiella macgintyi*. Their specimen (USNM 204069) is not a typical example of the species, as the intervarical areas are smoother and the varices less frondoes than *M. macgintyi*. However, there is no other form to which it is closer. It may be a ecologic variant due to the slightly cooler habitat; or, it may prove to be a new species.

Murexiella (Murexiella) petuchi Vokes, n. sp.

Plate 13, figures 1-3

Description: Shell small (maximum height about 13 mm) with five teleoconch whorls; protoconch of one and one-half smooth, tabulate whorls with a rounded keel beginning at posterior tip but gradually moving to mid-point, then dying out before reaching small terminal varix. Spiral ornamentation on first teleoconch whorl of a single cord placed near anterior suture; on second teleoconch whorl a second strong cord developed at shoulder. Two cords on all whorls up to body whorl, the latter with four strong cords. Axial ornamentation on first teleoconch whorl of seven small lamellar varices, decreasing to five or six on body whorl. Varices gradually becoming increasingly complex by addition of multiple layers of shelly material, scalloped by spiral ornamentation. By second teleoconch whorl strong, adapically-directed spines developed at intersection of shoulder cord and varices with another weaker spine at intersection of sutural cord and varices. On body whorl long sharp, abaperturally-directed spines at each major cord, that at shoulder recurved apically as well. Varical faces marked by a series of grooves formed in the multiple layers at each major spiral, between these grooves elaborate webbing formed by the layers. Shell surface between the varices almost smooth, marked only by major spiral cords and a few growth lamellae. Shell smooth on anterior portion of body whorl, the only indication of spiral ornamentation on siphonal canal seen on edge of varices with one moderately large spine, flanked by a smaller spine on either side. Suture impressed. Aperture ovate; inner lip smooth, free-standing in anterior portion, appressed in posterior portion; no anal notch. Inner side of outer lip with six small denticles, margin crenulated by major spiral cords. Siphonal canal moderately long, strongly reflected, a series of spurs at former terminations, giving rise to a small fasciole.

Holotype: USNM 482042; height 13.2 mm, diameter 8.2 mm.

Type locality: TU 1000, Pinecrest Beds [= Fruitville Formation]; APAC pits at east end of 17th St., about 8 miles east of U.S. Highway 301 (now northwest corner of Fruitville Rd. exit, I-75) at Sarasota (T36S, R19E), Sarasota County, Florida.

Etymology of name: In honor of Edward J. Petuch, Florida Atlantic University, Boca Raton, Florida, for his on-going work on the southern Florida fossil mollusks.

Occurrence: Pinecrest Beds [= Fruitville Formation], Florida.

Figured specimens: Fig. 1, USNM 482042 (holotype). Fig. 2, USNM 482043 (paratype A); height 10.6 mm, diameter 6.4 mm; locality TU 1000. Fig. 3, USNM 482044 (paratype B); height 5.8 mm, diameter 3.7 mm; locality TU 1000. Additional locality: TU 1524.

Discussion: At TU 1000, the well-known locality at Sarasota, Florida, there are rare specimens (12 in the Tulane Collections) of a small species of *Murexiella* that is readily distinguished from all of its congeners by the flaring varices, smooth body whorl, and the keeled protoconch. It most nearly resembles the Recent eastern Pacific *M. laurae* Vokes, 1970; however, the latter has a multiwhorl protoconch, five major spiral cords on the body whorl, and stronger spines on the siphonal canal. In addition, in the adult *M. laurae* the spiral cords disappear and the shell surface is essentially smooth between the varices.

Of all of the species of *Murexiella, M. petuchi* is unique in its keeled protoconch,

similar to that seen in species of *Risomurex* (see Radwin and D'Attilio, 1976, text-fig. 109). Like other members of the "*M. glypta* complex" (especially *M. puntagordanum*), this species has several small denticles on the inner side of the outer lip, giving somewhat the aspect of a species of *Pygmaepterys*. Nevertheless, the shell ornamentation, with long recurved varical spines and a smooth shell surface, is more similar to *Murexiella* and this is the best placement for this admittedly intermediate form.

The type specimen is the largest seen and it was collected by Ms. Susan Khan, New Port Richey, Florida, who requested that the species be named in honor of Dr. Petuch, a sentiment I heartily endorse.

MUREXIELLA (MUREXIELLA) STEPHENSAE
Vokes, n. sp.
Plate 13, figures 4, 5

Description: Shell with five teleoconch whorls; protoconch and earliest ornamentation missing in all specimens of type lot. Spiral ornamentation on second teleoconch whorl of two strong cords, one at shoulder, one near anterior suture. Two cords on all whorls up to body whorl, the latter with five strong cords and two to three additional cords on siphonal canal. Axial ornamentation on each teleoconch whorl of eight to ten varices, gradually increasing in size and complexity by addition of multiple layers of shelly material; the latter filigreed between the major cords. By second teleoconch whorl strong, adapically-directed spines developed at intersection of shoulder cord and varices with another weaker spine at intersection of sutural cord and varices. On body whorl long, elaborately ramose, abaperturally recurved spines at each major cord, plus one smaller spine on shoulder ramp where no spiral cord exists. Except for major spiral cords shell surface smooth between varices. Suture impressed. Aperture ovate; inner lip smooth, free-standing in anterior portion, appressed in posterior portion; no anal notch. Inner side of outer lip smooth, margin crenulated by major spiral cords. Siphonal canal relatively long, recurved at distal end giving rise to a series of spurs at former terminations.

Holotype: USNM 482045; height 18.6 mm, diameter 11.3 mm.

Type locality: TU 1493, (?)Tamiami Formation; Arvida Pit, on Bird Road (= W. 40th St.), approximately 5 miles west of Florida Turnpike, on west side of Coral Gables, Dade County, Florida.

Etymology of name: In honor of Susan B. Stephens (Mrs. John Stephens), Sanibel, Florida, for her continued generosity in providing specimens for study, including the type material for this new species.

Occurrence: (?)Tamiami Formation, Florida.

Figured specimens: Fig. 4, USNM 482045 (holotype). Fig. 5, USNM 482046 (paratype); height 16.0 mm, diameter 9.9 mm; locality TU 1493.

Discussion: This new species has much the aspect of *M. macgintyi* but differs in that the spines are greatly extended past the edge of the varices. These digitations are strongly recurved, almost touching the shell whorl, and extremely ramose. At present, the form is known only from the type locality, which is a more reefal environment than the typical *M. macgintyi* habitat. It may be only an ecologic variant but the material on hand seems to be consistently different.

The type lot of this new species consists of eight specimens (of these, five were collected by Mrs. Stephens; three by Edward J. Petuch), all from the type locality. In addition to the figured types, there are now four paratypes in my collection, the largest of which measures 24.5 mm in height. There are two additional paratypes in Mrs. Stephens' collection, one 18.5 mm in height, the other 17.2 mm in height.

The species closest to *M. stephensae* is the Aruba endemic form *M. hilli*. They differ in size, the smaller *M. stephensae,* with six teleoconch whorls, is little more than one-half the size of *M. hilli* (24 mm *vs.* 40 mm in height). The spiral cords in the intervarical areas are stronger in *M. stephensae* and the varical spines are shorter but more ramose. *Murexiella stephensae* and not *M. faceta* is the presumed ancestor of *M. hilli*.

The formational name to be applied to the Bird Road beds is questionable. The locality was first reported by Petuch (1986, p. 392), who noted that the locality is a Pliocene reef-tract, which he considered part of an ancient atoll-like structure. Everyone agrees that the fossils from the Bird Road locality are the same age as those from the familiar "Pinecrest Beds" of western Florida; but, whether all Late Pliocene molluscan faunas in southern Florida should be referred to the "Pinecrest Beds" is less certain.

Meeder (1990, fig. 3) has placed the Pinecrest-age reefal beds of western Florida in the Tamiami Formation. If Petuch is cor-

rect in including the reef-tracts on either side of the peninsula in one continuous reefal structure, then the eastern reef and the western reef are essentially one lithologic unit. This seems reasonable for the east, south, and west parts of the region, parallel to the present coastline, although not the northern part, which Petuch also included and for which there is absolutely no paleontological evidence. Thus, I am considering the Bird Road locality to be a part of the Tamiami Formation of Meeder (1990)*, if not of Mansfield (1939).

The faunas of these eastern and western reefs, although closely related to the Pinecrest fauna, do have certain differences. For example, at localities in the western reef-tract (TU 1174, 1175, 1177) we have no examples of *Murexiella shilohensis* or *M. faceta,* both of which are common at most typical "Pinecrest" localities.

*This is almost certainly a misnomer, for the name "Tamiami," as used by Meeder was a generic term for the entire "Pinecrest-Buckingham-Tamiami" facies group. In its type area, the Tamiami (named for the Tamiami Trail, now U.S. Highway 41) was described as a "hard, porous, non-oolitic limestone with inclusions of clear quartz grains. The cavities were originally occupied by the tests of organisms, mainly mollusks." (Mansfield, 1931, p. 43). The only fauna still present is those calcitic organisms, such as oysters, echinoids, and pectens that have withstood leaching. Obviously this is not the reefal facies but the platform enclosed by the reef. The specimens from Bird Road, such as *M. stephensae,* are encrusted with a hard calcareous matrix bearing large clear quartz grains, but the aragonitic shells are still present, in contrast to Mansfield's description.

Murexiella (Murexiella) levicula (Dall)
Plate 16, figures 1-3

Ocinebra (Favartia) (cellulosa var.?) *levicula* DALL, 1889, Harvard Mus. Comp. Zool., Bull., v. 18, p. 211, pl. 16, fig. 1 [as *Ocinebra (Favartia) cellulosa* Conrad, young].

Not *Tritonalia cellulosa levicula* (Dall). SMITH, 1939, Illus. Cat. Recent Species Rock Shells, p. 16, pl. 13, fig. 8 (SMITH, 1953, *ibid.*) [= *M. glypta* (Smith)].

Not *Murex [Favartia] cellulosus leviculus* (Dall). CLENCH and PÉREZ FARFANTE, 1945, Johnsonia, v. 1, no. 17, p. 56, pl. 28, figs. 1-3 [= *M. glypta* (Smith)].

Murex (Favartia) cellulosus Conrad. ABBOTT, 1954, Amer. Seashells, p. 204 (in part), fig. 45b (= Dall, 1889, pl. 16, fig. 1) (*not* of Conrad).

Not *Murex (Favartia) cellulosus leviculus* (Dall). ABBOTT, 1954, Amer. Seashells, p. 205, pl. 25j [= *M. glypta;* same figure as Clench and Pérez Farfante, 1945, pl. 28, fig. 1].

Not *Murex cellulosus leviculus* Dall. WARMKE and ABBOTT, 1961, Caribbean Seashells, p. 106, pl. 19h [= *M. macgintyi* (Smith)].

Murexiella (Murexiella) levicula (Dall). VOKES, 1968, Tulane Stud. Geol., v. 6, no. 3, p. 119, pl. 7, fig. 7 (lectotype).

Murex leviculus (Dall). PORTER and WOLFE, 1971, Jour. de Conchyl., v. 109, p. 96.

PLATE 15

Figures Page

1-7. *Murexiella (Murexiella) glypta* (Smith) 112

1. (X 2 1/2) USNM 482049; height 21.5 mm, diameter 13.0 mm.
   Locality: TU 767, Caloosahatchee River, Florida. (?)Caloosahatchee Formation.
2. (X 3) USNM 645895; height 17.0 mm, diameter 9.5 mm.
   Locality: TU 580, North New River Canal, Florida. Bermont Formation.
3. (X 2 1/2) USNM 482050; height 21.5 mm, diameter 13.8 mm.
   Locality: TU 1240, Los Corales, Costa Rica. Moín Formation.
4. (X 3) USNM 880016; height 17.0 mm, diameter 9.4 mm.
   Locality: Buzios Island, São Paulo, Brazil. Recent.
5. (X 4) USNM 838037; height 12.0 mm, diameter 7.0 mm.
   Locality: TU R-99, off Quintana Roo, Mexico. Recent.
6. (X 6; protoconch X 10) USNM 838041; height 8.2 mm, diameter 5.0 mm.
   Locality: TU R-99, off Quintana Roo, Mexico. Recent.
7. (X 6) USNM 780652 (holotype – *Murexiella iemanja* Petuch); height 7.9 mm, diameter 4.9 mm.
   Locality: Abrolhos Archipelago, Brazil. Recent.

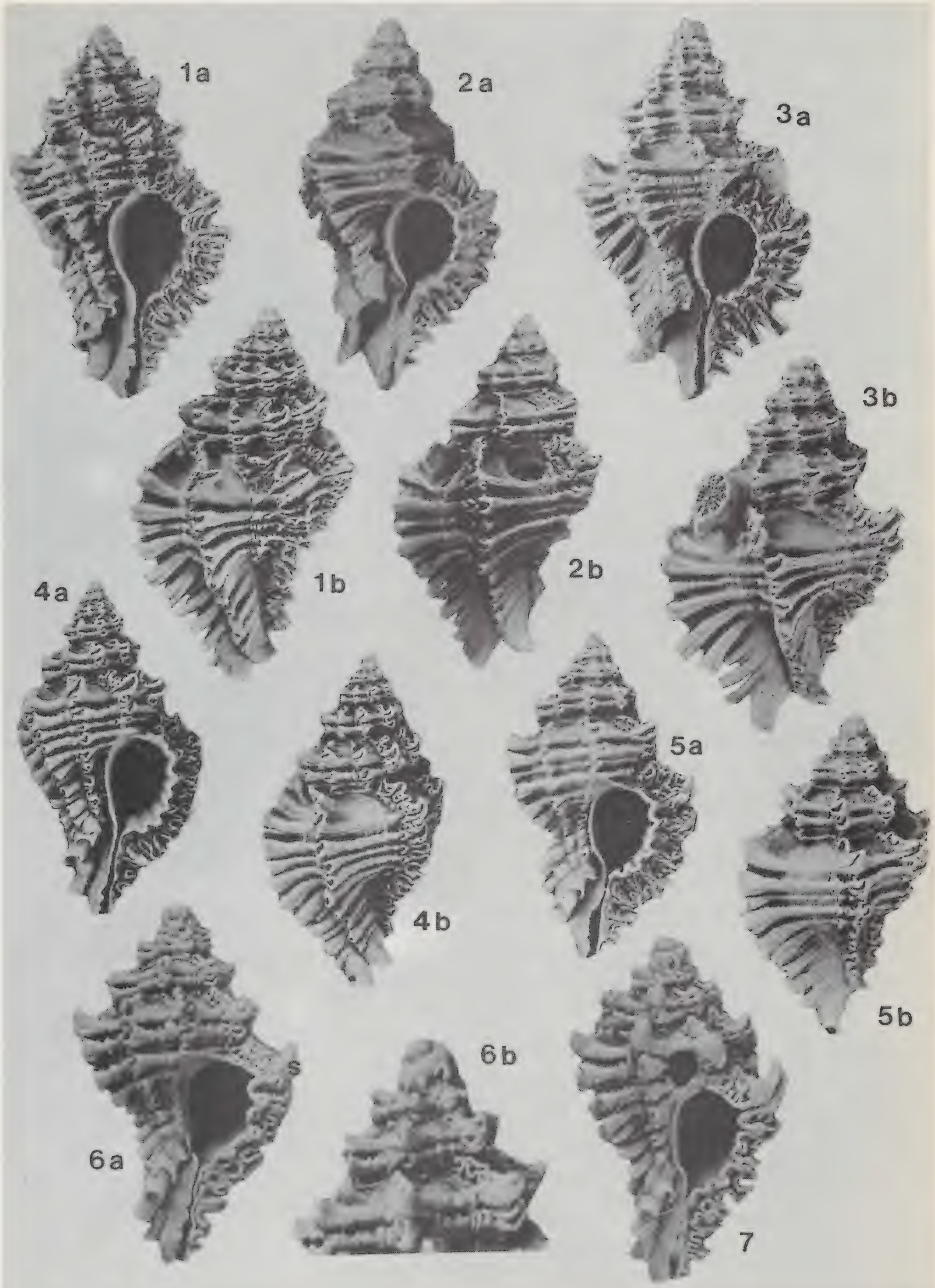

PLATE 15

Murex (Murexiella) leviculus Dall. ABBOTT, 1974, Amer. Seashells (ed. 2), p. 175.

Murexiella levicula (Dall). KAICHER, 1974, Card Catalogue World-wide Shells, pack 6, Muricidae – Part II, no. 563; RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 159 (in part), pl. 26, fig. 10; FAIR, 1976, The Murex Book, p. 54, pl. 19, figs. 268, 268a, 273 (lectotype, after Vokes); VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 212, pl. 2, fig. 4; SUNDERLAND and SUNDERLAND, 1992, Amer. Conchologist, v. 20, no. 3, p. 14, text-fig.

Description: "This form differs from the typical *cellulosa* in being somewhat smaller and more slender, with one less varix on the average and with the varices thinner, somewhat more branched, and each forming a sharp-edged rather than a broadish rounded ridge. The revolving ribs are feebler, and in nearly all the specimens entirely obsolete over most of the space between the varices on the last whorl. This gives the shell a very different aspect, but a tendency to such a condition is seen in some specimens of *cellulosa* and other apparently allied species." (Dall, 1889)

Lectotype: USNM 93271 (designated by Vokes, 1968, p. 119); height 18 mm, diameter 10 mm.

Type locality: Albatross Station 2372, 60 miles [97 km] south of Cape San Blas, Florida, 27 fathoms [49 meters] (designated by Vokes, 1968, p. 119).

Occurrence: (?)Pinecrest Beds [= Fruitville Formation]; Holocene, Louisiana; Recent, North Carolina to Gulf of Mexico.

Figured specimens: Fig. 1, Stephens Collection; height 16.6 mm, diameter 10.0 mm; locality TU 1000. Fig. 2, USNM 838039; height 5.3 mm, diameter 3.4 mm; locality TU 977. Fig. 3, USNM 838040; height 16.8 mm, diameter 9.7 mm; locality TU R-42.

Discussion: As discussed earlier (Vokes, 1968, p. 119), *Murexiella levicula* repeatedly has been confused with *M. glypta* (Smith), which is only generically similar. Even though it was shown (*ibid.*, p. 117) that *M. levicula* has a protoconch of four conical whorls and *M. glypta* has one and one-half bulbous whorls (compare pl. 16, fig. 2, and pl. 15, fig. 6), Radwin and D'Attilio (1976, p. 159) placed *M. glypta* in synonymy with *M. levicula.* The shell has spiral ribs until the fifth teleoconch whorl, where it becomes smooth between the varices. Thus, juvenile specimens may be mis-

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PLATE 16

Figures Page

1-3. *Murexiella (Murexiella) levicula* (Dall) 108
1. (X 3) Stephens Collection; height 16.6 mm, diameter 10.0 mm.
Locality: TU 1000, Sarasota, Florida. Pinecrest Beds.
2. (X 10) USNM 838039; height 5.3 mm, diameter 3.4 mm.
Locality: TU 977, Mississippi River Delta, Louisiana. Holocene.
3. (X 3) USNM 838040; height 16.8 mm, diameter 9.7 mm.
Locality: TU R-42, Anna Maria Key, Florida. Recent.

4. *Murexiella (Murexiella) veracruzana* Vokes 112
(X 3) USNM 482051; height 13.1 mm, diameter 7.8 mm.
Locality: TU 1046, Veracruz, Mexico. Agueguexquite Formation.

5, 6. *Murexiella (Murexiella) puntagordanum* (Weisbord) 114
5. (X 3) NMB H 17469; height 17.9 mm, diameter 10.0 mm.
Locality: Playa Grande, Dist. Federal, Venezuela. Recent.
6. (X 10) NMB H 17470; height (incomplete) 4.5 mm, diameter (incomplete) 3.5 mm.
Locality: Farallon Sentinela, Venezuela. Recent.

7. *Murexiella (Murexiella) petiti* Vokes 115
(X 2 1/2) USNM 645893 (holotype); height 21.0 mm, diameter 15.0 mm.
Locality: TU 558, Crescent Beach, South Carolina. Waccamaw Formation.

8. *Murexiella (Murexiella) kalafuti* Petuch 116
(X 3) Sunderland Collection; height 15.4 mm, diameter 9.8 mm.
Locality: off Key West, Florida. Recent.

9. *Murexiella (Murexiella)* species 100
(X 4) USNM 645987; height 10.3 mm, diameter 6.4 mm.
Locality: USGS 23737, Santa Rosa, Veracruz, Mexico. (?)Medias Aguas Formation.

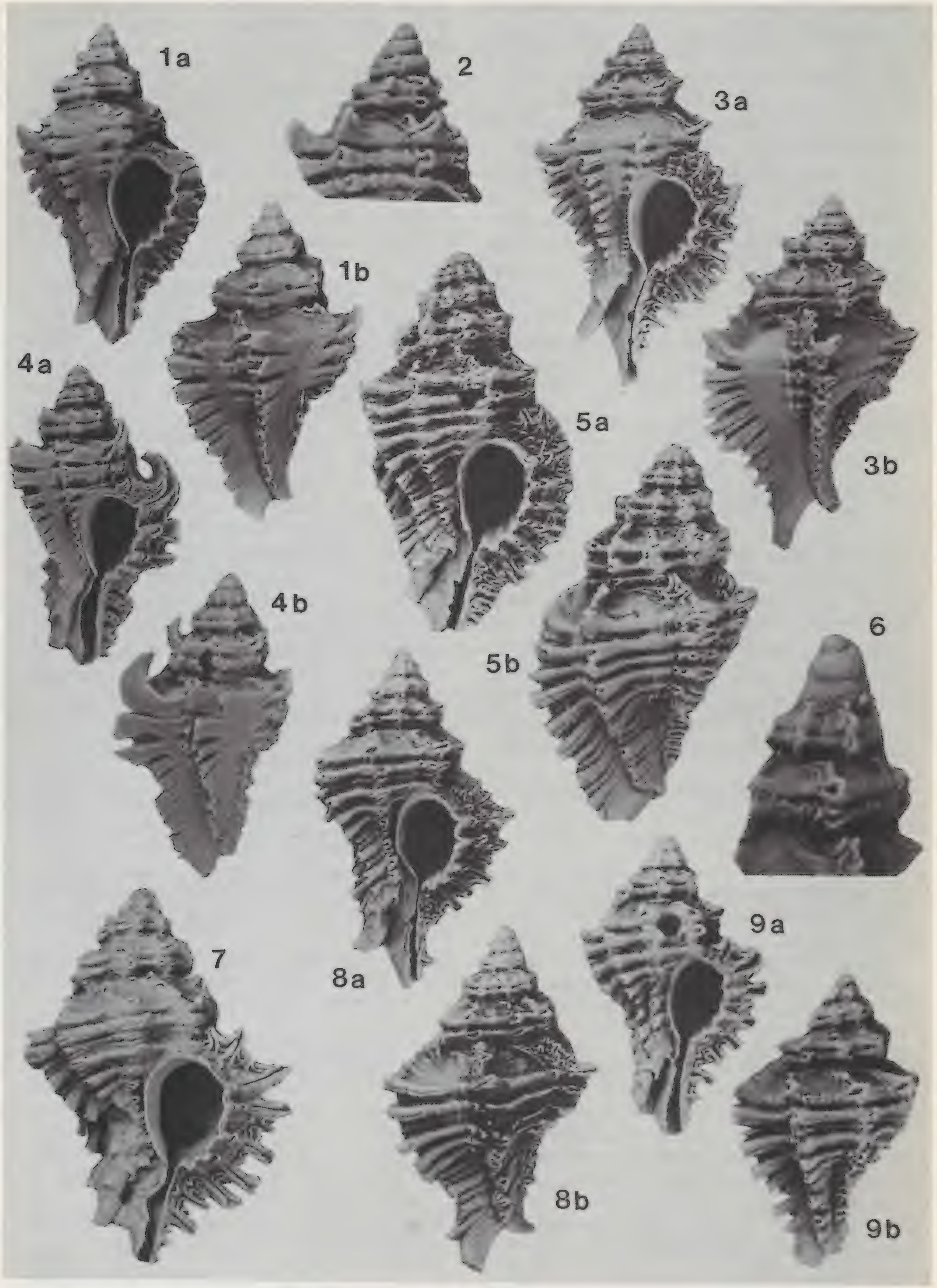

PLATE 16

taken for the similar, strongly ribbed *M. glypta,* but the protoconch (which is commonly preserved) immediately identifies this species.

Murexiella levicula is most abundant in the Gulf of Mexico, in depths of 20 to 70 meters; for example, it is common in the Holocene "Mudlump-90" fauna (TU 977) off the Mississippi River delta, in beds estimated to have been deposited in 60 meters (Morgan *et al.*, 1963, p. 41). Previously (Vokes, 1968, p. 119) I questioned Dall's record off the North Carolina coast, but more recently Porter and Wolfe (1971, p. 96) have recorded the species off North Carolina and numerous examples have been taken by the scallop boats working out of St. Augustine, Florida.

Although *M. levicula* has not been reported as fossil, in the collection of Mrs. Susan B. Stephens, Sanibel, Florida, there is a single example (pl. 16, fig. 1) from Sarasota, Florida (TU 1000). However, material from this locality is primarily from spoil and the precise stratigraphic placement is uncertain. Although most Sarasota material is from the Pinecrest Beds, at the APAC pit both Caloosahatchee and Bermont formations are present (see Vokes, 1992, p. 2 for further discussion). Provisionally, we will assign this occurrence to the Pinecrest Beds but this is not certain.

Murexiella (Murexiella) veracruzana Vokes
Plate 16, figure 4

Murexiella (Murexiella) veracruzana VOKES, 1968, Tulane Stud. Geol., v. 6, no. 3, p. 116, pl. 5, fig. 5.

Description: "Nature of early whorls and total number of whorls not known. Axial ornamentation on body whorl consisting of five sharp, straight varices. Spiral ornamentation on body whorl of five flattened ribs marked by a strong median groove in each. Where the spiral ribs cross the varices, small open spines produced which are noticeably square in cross-section; spines connected by a laminated webbing. One small spine between shoulder spine and suture with no corresponding spiral rib; shoulder spine larger than all other spines. Varices extending the length of the anterior canal and bearing small spinelets but no trace of spiral ornamention on canal. Aperture small, oval, almost entire. Outer lip with five crenulations corresponding to the five major varical spines. Inner lip smooth, standing free from columellar wall. Siphonal canal long, straight, probably recurved at extreme tip but broken in holotype." (Vokes, 1968)

Holotype: USNM 645894; height (incomplete) 12.7 mm, diameter (incomplete) 7.0 mm.

Type locality: TU 638, Agueguexquite Formation; quarry on south side of Mexico Highway 180, 14 miles [28 km] east of junction with side road into Coatzacoalcos, Veracruz, Mexico.

Occurrence: Agueguexquite Formation, Mexico.

Figured specimen: USNM 482051; height 13.1 mm, diameter 7.8 mm; locality TU 1046.

Discussion: Since the description of this species from the Agueguexquite Formation (now dated as mid-Pliocene rather than Upper Miocene) we have collected several additional fragmentary specimens. Only the one figured here (pl. 16, fig. 4) is nearly complete. This species may be distinguished from all other similar forms by the very flattened nature of the spiral ornamentation, which looks almost as though it had been "ironed" flat. The shoulder spine is extremely recurved adapically.

Originally, I suggested that this species was the ancestor of the younger *Murexiella levicula.* But, if the Sarasota specimen mentioned above is, in fact, from the Pinecrest Beds, the two species were contemporary.

Murexiella (Murexiella) glypta (Smith)
Plate 15, figures 1-7

Murex glyptus M. SMITH, 1938, Nautilus, v. 51, no. 3, p. 89, pl. 6, fig. 10.

Tritonalia cellulosa levicula (Dall). SMITH, 1939, Illus. Cat. Recent Species Rock Shells, p. 16, pl. 13, fig. 8 (SMITH, 1953, *ibid.*) (*not* of Dall).

Murex [Favartia] cellulosus leviculus Dall. CLENCH and PÉREZ FARFANTE, 1945, Johnsonia, v. 1, no. 17, p. 56, pl. 28, figs. 1-3 (*not* of Dall).

Murex (Favartia) cellulosus leviculus (Dall). ABBOTT, 1954, Amer. Seashells, p. 205 (in part), pl. 25, fig. j (same figure as Clench and Pérez Farfante, 1945, pl. 28, fig. 1) (*not* of Dall).

Murexiella (Murexiella) glypta (Smith). VOKES, 1968, Tulane Stud. Geol., v. 6, no. 3, p. 117, pl. 7, figs. 4 (holotype), 5.

Murex (Murexiella) glyptus Smith. ABBOTT, 1974, Amer. Seashells (ed. 2), p. 174.

Murexiella glypta (Smith). KAICHER, 1974, Card Catalogue World-wide Shells, pack 6, Muricidae – Part II, no. 554; RIOS, 1975,

Brazilian Marine Moll. Icon., p. 86, pl. 24, fig. 351; RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 159 (in synonymy with *M. levicula*); FAIR, 1976, The Murex Book, p. 46, pl. 20, fig. 277 (holotype, after Vokes); VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 212, pl. 2, fig. 8; RIOS, 1985, Seashells of Brazil, p. 85, pl. 30, fig. 373.

Murexiella iemanja PETUCH, 1979, Biol. Soc. Washington, Proc., v. 92, no. 3, p. 518, figs. 1-I, 1-J; PETUCH, 1987, New Caribbean Moll. Faunas, p. 140, pl. 16, figs. 4, 5 (holotype); KAICHER, 1980, Card Catalogue Worldwide Shells, pack 25, Muricidae – Part V, no. 2595; PETUCH, 1988, Neogene Hist. Trop. Amer. Moll., p. 163, pl. 39, figs. 16, 17 (holotype).

Favartia (Murexiella) glypta (Smith). HOUART, 1991, Nautilus, v. 105, no. 1, p. 32.

Description: "Nucleus of holotype imperfect, whorls about seven; suture well impressed; spiral sculpture consisting upon the body whorl of about twelve rounded ribs, arranged arc shaped from axial rib to rib, often marked with a division line in the center, the major termination of the axial sculpture turned backward from the direction of growth, openings beneath away from the recurved points. The eight axial eminences are sharp and largely formed by foliated processes. Aperture small, oval in shape; canal slightly oblique, almost closed." (Smith, 1938)

Holotype: UF 1311; height 25.3 mm, diameter 14.0 mm.

Type locality: Caloosahatchee Formation; Clewiston, Hendry County, Florida.

Occurrence: Caloosahatchee and Bermont formations, Florida; Waccamaw Formation, South Carolina; Moín Formation, Costa Rica; Recent, from Gulf of Mexico to São Paulo, Brazil.

Figured specimens: Fig. 1, USNM 482049; height 21.5 mm, diameter 13.0 mm; locality TU 767. Fig. 2, USNM 645895; height 17.0 mm, diameter 9.5 mm; locality TU 580. Fig. 3, USNM 482050; height 21.5 mm, diameter 13.8 mm; locality TU 1240. Fig. 4, USNM 880016; height 17.0 mm, diameter 9.4 mm; locality, Buzios Island, São Paulo, Brazil. Fig. 5, USNM 838037; height 12.0 mm, diameter 7.0 mm; locality TU R-99. Fig. 6, USNM 838041; height 8.2 mm, diameter 5.0 mm; locality TU R-99. Fig. 7, USNM 780652 (holotype – *Murexiella iemanja* Petuch); height 7.9 mm, diameter 4.9 mm; locality, Abrolhos Archipelago, Brazil. Additional localities: TU 529B, 536, 558, 727, 759, 803, 991.

Discussion: Murexiella glypta is, as most species of the genus, extremely variable. The varices range in number from four to eight, with a resulting change in the appearance of the shell (compare pl. 15, figs. 2, 3 with four varices to fig. 1 with eight varices). This variability may have caused Houart (1991, p. 32) to consider the specimen from the Bermont Formation (figured previously by Vokes, 1968, pl. 7, fig. 5; refigured here, pl. 15, fig. 2) an example of *Favartia cellulosa* (Conrad).

Originally, the species was known only from the Recent fauna, Gulf of Mexico, but additional specimens have extended the range to northern South America, where this species also was named *Murexiella iemanja* Petuch, as noted by Rios (1985, p. 85).

Murexiella (Murexiella) edwardpauli Petuch

Plate 12, figures 4-7

Murexiella edwardpauli PETUCH, 1990, Nautilus, v. 104, no. 2, p. 62, figs. 6, 7.

Description: "Shell small for genus, thin, delicate, with globose, inflated body; 6 varices per whorl, varices thin, with 6 large, recurved spines; intervarical areas ornamented with 6 large spiral cords; intervarical cords and varices minutely squamose; siphonal canal proportionally very elongated; ornamented with 3 large, flattened spines per siphonal varix; shell consistently pinkish-tan colored with 2 darker tan bands, one around shoulder and one around midbody; shoulder of body whorl slightly angled; aperture proportionally large, oval in shape." (Petuch, 1990)

Holotype: USNM 860529; height 15.2 mm, diameter 9.3 mm.

Type locality: Off Portobelo, Panama, 50 meters.

Occurrence: Agueguexquite Formation, Mexico; (?)Caloosahatchee Formation, Florida; Moín Formation; Costa Rica; Recent, Panama.

Figured specimens: Fig. 4, USNM 860529 (holotype). Fig. 5, USNM 482038; height 18.0 mm, diameter 10.0 mm; locality TU 1023. Fig. 6, USNM 482039; height 17.7 mm, diameter 10.8 mm; locality TU 1046. Fig. 7, USNM 482040; height 14.8 mm, diameter 8.7 mm; locality TU 954.

Discussion: This species from the Atlantic coast of Panama has a marked similarity to *M. macgintyi* but differs in having a longer siphonal canal. Several specimens from different geological formations, ranging in age back to the mid-Pliocene Agueguexquite Formation, Veracruz, Mexico, have this same morphology. Whether they are variations of typical *M. macgintyi* is not certain but the differences appear to be consistent.

MUREXIELLA (MUREXIELLA) PUNTAGORDANUM
(Weisbord)
Plate 16, figures 5, 6

Murex (Favartia) puntagordanum WEISBORD, 1962, Bulls. Amer. Paleontology, v. 42, no. 193, p. 292, pl. 26, figs. 7, 8.

Murexiella (Murexiella) puntagordanum (Weisbord). VOKES, 1968, Tulane Stud. Geol., v. 6, no. 3, p. 118.

Description: "Shell small, with a little over five whorls, including the nucleus. Nucleus smooth, consisting of about 1 1/4 [2 1/2] whorls, the tip loosely coiled and somewhat immersed, the last turn narrow and rounded. Post-nuclear whorls shouldered, the sculpture consisting of axial folds which later develop into varices, and spiral riblets, of which there are three to five on the whorls of the spire. On the body whorl there are six high narrow varices and seven or eight strong, elevated, flat-topped primary spiral ribs separated by deep interspaces in either side of which there is a spiral thread close to the primary rib. On the whorls of the spire, the spiral riblets are narrow and tend to bifurcate on the crests of the axial folds and varices. On the ramp above the shoulder, spiral lineations are wanting or obsolescent throughout although the varices continue across the ramp to the suture. All of the six axials on the body whorl are true varices, and these are built up by incremental growth laminae into short spines whose tips are bent backward, the spines being channeled below the tip with the hollows open toward the aperture. These spines or pointed arches are produced on the narrow crest of the varices at the crossing or intercept of the spiral primary rib, and thus there are as many spines as there are spiral ribs on each varix. Surface of shell traversed with growth lamellae and it is these which, by incrementation at the varix, produce the 'cellular' structure or spines. Aperture asymmetrically oval, the entrance to the siphonal canal wide, the posterior outlet covered over by the callus of the parietal shield. Outer lip with about seven denticles along the inner margin, the varix rising from the rim. Previous siphonal canal prominent, convex, bordered by an unbilicate [*sic*] depression. Present siphonal canal broken at the anterior end, but is probably relatively short." (Weisbord, 1962)

Holotype: PRI 26202; height (incomplete) 13.0 mm, diameter 8.0 mm.

Type locality: "Playa Grande Formation" [= Mare Formation]; north flank of Punta Gorda anticline, Cabo Blanco, Dist. Federal, Venezuela.

Occurrence: Mare Formation, Venezuela; Recent, Venezuela.

Figured specimens: Fig. 5, NMB H 17469; height 17.9 mm, diameter 10.0 mm; locality, Playa Grande, Dist. Federal, Venezuela. Fig. 6, NMB H 17470; height (incomplete) 4.5 mm, diameter (incomplete) 3.5 mm; locality, Farallon Sentinela, Venezuela, 15 meters.

Discussion: Weisbord described this species from the Maiquetia Member of the Playa Grande Formation, of Late Miocene or Early Pliocene age. Mr. and Mrs. Jack Gibson Smith, formerly of Caracas, who have done much work on the stratigraphy of the coastal area of Venezuela, in a discussion of the Mare Formation (1979, p. 24), noted that at Punta Gorda there are two fossiliferous beds separated by 20 feet of barren conglomerate. The lower one was assigned by Weisbord (1957, p. 14) to the Maiquetia Member of the Playa Grande Formation (his loc. W-23, type locality for *M. puntagordanum);* the upper one he assigned to the Mare Formation. However, as the Gibson Smiths have observed, the beds can be traced westward along the strike into the type area of the Mare Formation (Quebrada Mare Abajo); thus, W-23 also is part of the Mare Formation.

In a letter, Mr. Gibson Smith (October, 1993) writes "at Punta Gorda the sequence pertains entirely to the Mare Formation and consists of a conglomeratic, nearshore facies, with a *Lithothamnium* bioherm near the base at road level and three intercalated shell beds above. The sequence is capped by the unconformably overlying Abisinia Fm. The Maiquetia Member element described by Weisbord has not been recognized."

Weisbord considered the Playa Grande Formation to be Late Miocene or Early Pliocene in age and the "overlying" Mare Formation to be probably Late Pliocene. Based on planktic foraminifera the age of the Playa Grande has been revised upward to the Pleistocene. Gibson Smith believes (1976, p. 4; personal communication, October, 1993) that the Mare Formation actually *underlies* the Playa Grande but, neverthelesss, is Late Pliocene, based upon the occurrence of *Globorotalia tosaensis tenuitheca* Blow.

As previously discussed (Vokes, 1968, p. 118), the holotype of *M. puntagordanum* is so poorly preserved that little could be determined from it. However, there are several well-preserved specimens from the Recent fauna off the coast of Venezuela in the Gibson Smith Collection at the

Naturhistorishes Museum, Basel, one of which is figured here (pl. 16, fig. 5). These specimens do have a marked resemblance to *M. glypta* but a juvenile example of the species, collected by Mr. Gibson Smith, shows a protoconch of two and one-half whorls (pl. 16, fig. 6). The shoulder is more rounded in *M. puntagordanum,* with the maximum diameter at the mid-line of the whorl, in contrast to the more triangular outline of the whorl in *M. glypta.* Although the shells of the two species are similar in appearance, they are distinct species.

MUREXIELLA (MUREXIELLA) GRACEAE
(McGinty)
Plate 12, figure 8

Tritonalia graceae MCGINTY, 1940, Nautilus, v. 53, no. 3, p. 84, pl. 10, fig. 2.
Murexiella (Murexiella) graceae (McGinty). VOKES, 1968, Tulane Stud. Geol., v. 6, no. 3, p. 118, pl. 7, fig. 6.

Description: "Shell small, spire low, about 5 whorls (nucleus lost), suture appressed, indistinct; whorls shouldered; about 7 foliated ribs or varices; ribs spined, stronger and some recurved on the crown; double row of basal spines in the siphonal region; aperture truncate-oval; canal straight, longer than the aperture." (McGinty, 1940)

Holotype: UF 23197; height 21.5 mm, diameter 16.0 mm.

Type locality: Bermont Formation; Belle Glade, Palm Beach County, Florida (= TU 201).

Occurrence: Bermont Formation, Florida.

Figured specimen: USNM 482041; height 20.1 mm, diameter 14.3 mm; locality TU 725. Additional localities: TU 727, 751, 1536.

Discussion: The Pleistocene *M. graceae* is the immediate ancestor of the Recent *M. taylorae* Petuch. In the younger species the spire is a bit higher and the shell becomes smooth between the varices at a slightly earlier stage; the shell generally has a less scabrous appearance.

MUREXIELLA (MUREXIELLA) PETITI
Vokes
Plate 16, figure 7

Murexiella (Murexiella) petiti VOKES, 1968, Tulane Stud. Geol., v. 6, no. 3, p. 116, pl. 5, fig. 3.

Description: "Shell markedly biconic; six whorls in the holotype, nucleus lacking. Spiral ornamentation consisting of two strong ribs on each of the spire whorls and five such ribs on the body whorl, becoming almost obsolete in the intervarical areas of the adult shell. In addition, on the body whorl a few small threads irregularly placed. Axial ornamentation of small equal varices, seven to each turn. Where the spiral ribs cross the varices, small foliaceous open spines are produced, five major spines on the body whorl and two more on the siphonal canal; between the shoulder spine and the suture two smaller spines developed, although no corresponding spiral ribs appear in the intervarical areas. Spines connected by a laminar webbing. Aperture round, almost entire; outer lip slightly crenulated by infolding into apertural spines; inner lip smooth and standing well forward from the columellar wall. Siphonal canal short, recurved, almost closed over by a thin plate, but remaining open by a narrow slit." (Vokes, 1968)

Holotype: USNM 645893; height 21.0 mm, diameter 15.0 mm.

Type locality: TU 558, Waccamaw Formation; borrow pits, north end of Crescent Beach Airport, Crescent Beach, Horry County, South Carolina.

Occurrence: Waccamaw Formation, South Carolina.

Figured specimen: USNM 645893 (holotype).

Discussion: No additional material has been recovered of *M. petiti* and nothing can be added to the description. Previously, it was suggested that this new species might be ancestral to *M. levicula,* which is also smooth between the varices. But, as noted above, we now have a specimen of *M. levicula* from the APAC quarry at Sarasota, probably older but certainly as old as the Waccamaw specimen.

In overall outline *M. petiti* is most closely related to the Recent *M. kalafuti* Petuch, also marked by a biconic outline, but the younger species has strong spiral cords where *M. petiti* is almost smooth between the varices of the body whorl.

MUREXIELLA (MUREXIELLA) HILLI Petuch
Plate 13, fig. 6

Murexiella macgintyi (Smith). KAICHER, 1973, Card Catalogue World-wide Shells, pack 2, Muricidae – Part I, no. 110; ABBOTT and DANCE, 1982, Compendium Seashells, p. 143, color fig.; DE JONG and COOMANS, 1988, Stud. Fauna Curaçao, Caribbean Islands, v. 49, p. 73 (in part) (*not* of Smith).
Murexiella n. sp. FAIR, 1976, The Murex Book, pl. 20, figs. 275, 275a; VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 212, back cover color photograph.
Murexiella hilli PETUCH, 1987, New Caribbean Moll. Faunas, p. 99, pl. 17, figs. 6, 7; KAICHER, 1991, Card Catalogue World-

wide Shells, pack 59, Muricidae – Part VI, no. 6100 (holotype).

Murexiella fasciatus [sic] (Vokes). SUNDERLAND and SUNDERLAND, 1992, Amer. Conchologist, v. 20, no. 3, p. 14, text-fig. [*not M. faceta* (Vokes)].

Description: "Shell large for genus, globose, with inflated whorls and rounded shoulders; spire moderately elevated; siphonal canal long, straight; aperture large in proportion to shell size, oval; 8 recurved varices per whorl; body whorl ornamented with 5 large, fimbriated cords between varices; large, recurved, fimbriated spine on varix where intersected by cord; subsutural area flattened, producing stepped spire; spire whorls with 2 fimbriated cords; siphonal canal with 3 large, fimbriated and branching curved spines; 2 smaller spines between 3 siphonal spines; siphonal spines curved posteriorward; color varying from white to pink, salmon (holotype), lavender and dark brown; brown band around subsutural area; siphonal canal generally white." (Petuch, 1987)

Holotype: USNM 869842; height 34 mm, diameter 22 mm.

Type locality: Malmok, Aruba Island, Netherlands Antilles, on mussel beds at low tide.

Occurrence: Recent only, Aruba, Netherlands Antilles.

Figured specimen: USNM 838034; height 35.4 mm, diameter 22.8 mm; locality, north coast of Aruba, 1 meter, on barnacles.

Discussion: Although closely related to *M. macgintyi,* this species differs in being more elaborately spinose. As the author notes, the siphonal canal bears three spines in addition to two smaller spines in the "pinched portion" between the body whorl, and the siphonal canal. The individual spines are extremely elongated and adaperturally recurved. In spite of the overall similarity to *M. macgintyi,* I believe this to be a valid, though very localized, species.

Murexiella (Murexiella) taylorae
Petuch
Plate 13, figure 7

Murexiella n. sp. FAIR, 1976, The Murex Book, pl. 20, figs. 274, 274a; VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 212, pl. 2, fig. 10.

Murexiella taylorae PETUCH, 1987, New Caribbean Moll. Faunas, p. 26, pl. 10, figs. 8, 9; PETUCH, 1988, Neogene Hist. Trop. Amer. Moll., p. 153, pl. 31, fig. 7 (holotype); KAICHER, 1991, Card Catalogue Worldwide Shells, pack 59, Muricidae – Part VI, no. 6080 (holotype); SUNDERLAND and SUNDERLAND, 1992, Amer. Conchologist, v. 20, no. 3, p. 14, text-fig.

Description: "Shell small for genus, with oval body, elevated spire, and long siphonal canal; 7 varices per whorl; varices with 6 large, strongly-recurved spines; intervarical areas with 6 large fimbriated cords; siphonal canal with 2 large, recurved spines; last spines of siphonal canal greatly recurved, almost touching varical spines; shoulder sharply angled; spire whorls tabulate; shell color rosy-tan with dark rose spots in pits at the base of each varix; siphonal canal pinkish-rose; interior of aperture pinkish-rose." (Petuch, 1987)

Holotype: USNM 859844; height 16.0 mm; diameter 6.4 mm.

Type locality: Off Cedar Key, Florida, trawled in 200 meters.

Occurrence: Recent only, Gulf of Mexico.

Figured specimen: USNM 838033; height 21.6 mm, diameter 14.8 mm; locality, west of Cape San Blas, Florida, 182 meters ["100 fathoms"].

Discussion: As Petuch noted in his description, this species differs from *M. graceae* "in being smaller, more globose in shape, and having a proportionally higher spire" (Petuch, 1987, p. 26).

Murexiella (Murexiella) kalafuti
Petuch
Plate 16, figure 8

Murexiella kalafuti PETUCH, 1987, New Caribbean Moll. Faunas, p. 14, pl. 1, figs. 7, 8; KAICHER, 1991, Card Catalogue Worldwide Shells, pack 59, Muricidae – Part VI, no. 6007 (holotype); SUNDERLAND and SUNDERLAND, 1992, Amer. Conchologist, v. 20, no. 3, p. 14, text-fig.

Description: "Shell small for genus, fusiform, with elevated spire; 6 varices per whorl; shoulder sharp-angled; body whorl with 5 large cords; cords end in thick, blunt spines, at intersection with varix; cords minutely fimbriated; varices heavily fimbriated; shell grayish-white with 2 wide, dark brown bands, one around mid-body and one around siphonal canal; suture marked with row of intermittent brown patches; siphonal canal with 2 large cords, producing 2 large spines at intersection with varix; aperture ovate, large in proportion to shell size; dark mid-body band showing through in aperture." (Petuch, 1987)

Holotype: USNM 859810; height 16.0 mm, diameter (including spines) 10.0 mm.

Type locality: 50 km south of Apalachicola, Florida, 150 meters.

Occurrence: Recent only, western and southern Florida.

Figured specimen: Sunderland Collection;

height 15.4 mm, diameter 9.8 mm; locality, lobster traps off Key West, Florida, 24 meters.

Discussion: Although there is a strong resemblance between *M. kalafuti* and *M. glypta,* the two species may be distinguished by the more biconic shape of *M. kalafuti,* and by the lack of a secondary cord, which is present at the periphery of *M. glypta,* between the major cords. As Petuch notes (1987, p. 15), the color pattern of *M. kalafuti* is most like the eastern Pacific *M. vittata* (Broderip, 1833). However, the number of varices (six in *M. kalafuti vs.* eight in *M. glypta,* according to Petuch, *ibid.*) is not a valid character for separation, as all species of *Murexiella* have a variable number of varices.

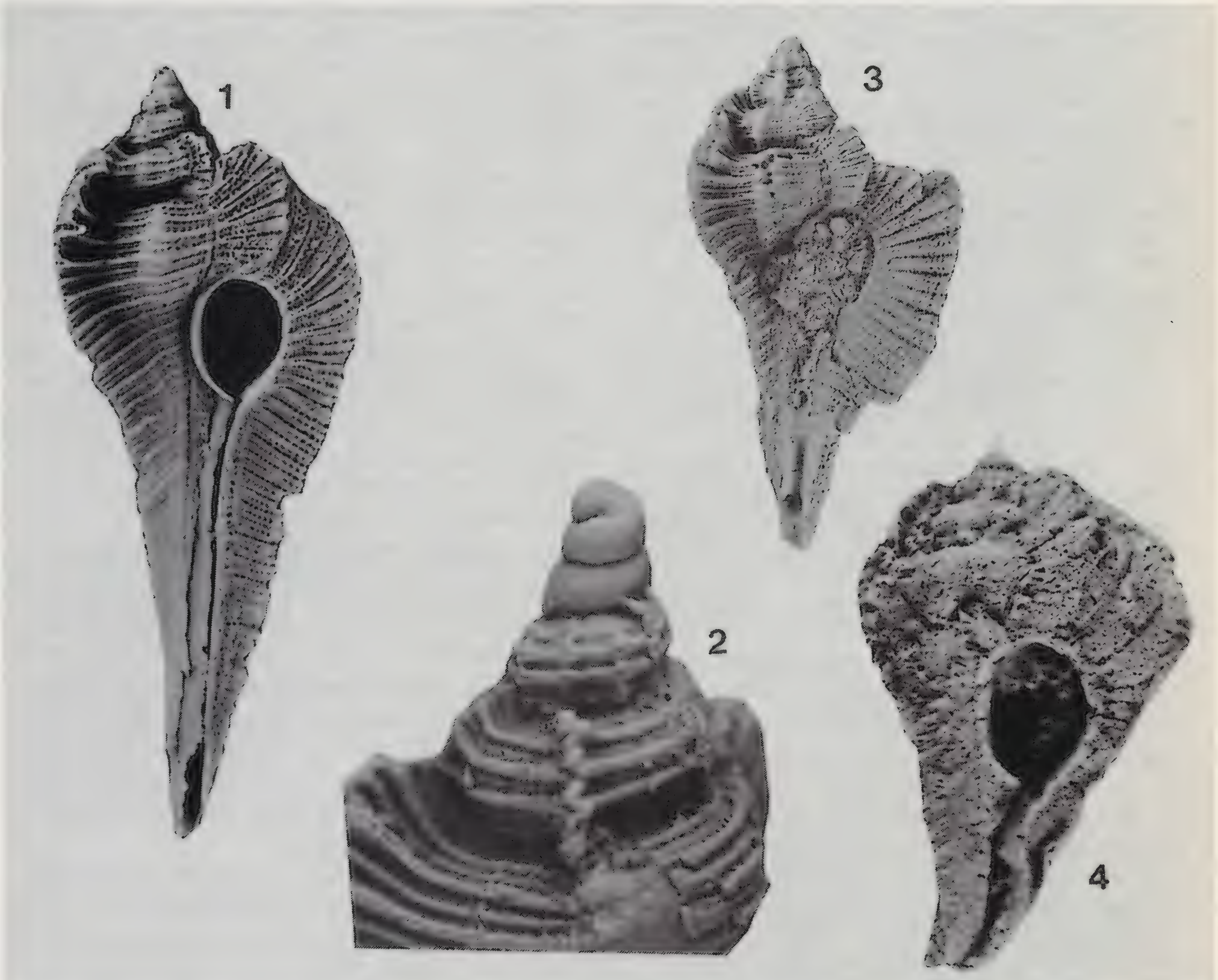

PLATE 17

Figures Page

1-4. *Murexiella (Subpterynotus) textilis* (Gabb) 118

1. (X 2 1/2) UF 47821; height 32.7 mm, diameter 12.4 mm.
   Locality: TU 1000, Sarasota, Florida. Pinecrest Beds.
2. (X 10) USNM 482052; height 13.5 mm, diameter 6.3 mm.
   Locality: TU 1000, Sarasota, Florida. Pinecrest Beds.
3. (X 1 1/2) NMB H 17468; height 39.0 mm, diameter 20.4 mm.
   Locality: NMB 17530, Carrizal, Venezuela. Caujaro Formation.
4. (X 1 1/2) USNM 482063; height 40.0 mm, diameter 25.4 mm.
   Locality: Santa Rosalia, Baja California Sur, Mexico. Boleo Formation.

Subgenus SUBPTERYNOTUS Olsson and Harbison, 1953

Subpterynotus OLSSON and HARBISON, 1953, Acad. Nat. Sci. Phila., Mon. 8, p. 246.

Type species: *Murex textilis* Gabb, 1873, by original designation.

Murexiella (Subpterynotus) textilis (Gabb)

Plate 17, figures 1-4

Murex (Pteronotus) textilis GABB, 1873, Amer. Phil. Soc., Trans., (N.S.) v. 15, p. 202; DALL, 1890, Wagner Free Inst. Sci., Trans., v. 3, pt. 1, p. 142, pl. 9, fig. 4 (on pl. expl. as *Pteronotus textilis*).

Murex textilis Gabb. GUPPY, 1876, Geol. Soc. London, Quart. Jour., v. 32, p. 522, pl. 29, fig. 1.

Murex (Pteropurpura) textilis (Gabb). PILSBRY, 1922, Acad. Nat. Sci. Phila., Proc., v. 73, p. 353, pl. 28, fig. 4 (holotype).

Murex (Subpterynotus) textilis (Gabb). OLSSON and HARBISON, 1953, Acad. Nat. Sci. Phila., Mon. 8, p. 247, pl. 36, fig. 7; DUBAR, 1958, Florida Geol. Surv., Bull. 40, p. 197, pl. 11, fig. 8; JUNG, 1965, Bulls. Amer. Paleontology, v. 49, no. 223, p. 521, pl. 69, figs. 8, 10.

Murexiella (Subpterynotus) textilis (Gabb). VOKES, 1968, Tulane Stud. Geol., v. 6, no. 3, p. 120, pl. 8, figs. 1 (holotype)-3; VOKES 1974, Malac. Soc. Australia, Jour., v. 3, no. 1, p. 10, pl. 2, fig. 3; VOKES, Bulls. Amer. Paleontology, v. 97, no. 332, p. 65, pl. 9, fig. 1 (holotype).

Pterynotus textilis (Gabb). WOODRING, 1970, U.S. Geol. Surv., Prof. Paper 306-E, p. 433, pl. 63, figs. 18, 19.

Description: "Shell compressed triangular; whorls eight, the first nuclear, the next three cancellate and showing little or no trace of varices, which show themselves on the next (fifth) distinctly for the first time, suture deep, caused by the great convexity of the whorls. Body whorl broad and flat above, then very convex near the top and tapering very gradually in advance. The three varices are thick at their bases, broad, acute and slightly recurved on the margin. Between each pair of varices there is one large prominent node, placed longitudinally, too broad to be called a rib. The entire surface is covered by about a dozen revolving ribs, except on the faces of the varices, where corresponding grooves take their places. Crossing these, the lines of growth are developed into minute erect plates, placed at equal distances and arching over all the ribs and intermediate, alternating lines, so as to produce under a lens, the effect of a lace, or loosely woven web. Aperture small, ovate; inner lip acute; outer lip faintly grooved internally; canal about twice as long as mouth and nearly, or entirely arched over." (Gabb, 1973)

Holotype: ANSP 3257; height 30.5 mm, diameter 16.0 mm.

Type locality: TU 1364, Baitoa Formation; Boca de los Ríos, below the waterfall in Arroyo Hondo, which enters Río Yaque del Norte from the east, just below the confluence with the Río Bao, downstream from Baitoa, Dominican Republic (restricted by Vokes, 1989, p. 66).

Occurrence: Baitoa Formation, Dominican Republic; Cantaure Formation and Mataruca Member, Caujarao Formation, Venezuela; Boleo Formation, Baja California Sur, Mexico; Gatun Formation, Panama; Pinecrest Beds [= Fruitville Formation], Chipola, Jackson Bluff, Tamiami, and Caloosahatchee formations, Florida.

Figured specimens: Fig. 1, UF 47821; height 32.7 mm, diameter 12.4 mm; locality TU 1000. Fig. 2, USNM 482052; height 13.5 mm, diameter 6.3 mm; locality TU 1000. Fig. 3, NMB H 17468; height 39.0 mm, diameter 20.4 mm; locality NMB 17530. Fig. 4, USNM 482063; height 40.0 mm, diameter 25.4 mm; locality, north of Santa Rosalia, Baja California Sur, Mexico (latex cast of natural mold in limestone). Additional localities: TU 60, 68, 79, 202, 203, 519, 520, 536, 546, 579, 583, 726, 728-730, 745, 755, 767-770, 797, 830, 939, 951, 975, 987, 991, 998, 1023, 1044, 1175, 1364, 1512, 1524.

Discussion: The stratigraphic placement of the holotype of *Murex textilis* Gabb has never been known. Neither the Maury (1917) nor the Vaughan *et al.* (1921) surveys collected a specimen of the species. Only after several years of work in the Dominican Republic did we finally discover one incomplete specimen in the Baitoa Formation, from a locality that we believe was one of Gabb's localities.

As noted in my original discussion (Vokes, 1968), the exact stratigraphic level is not of great scientific import, for this is the most widely distributed, both stratigraphically and geographically, of any species in the entire subfamily. In 1968 I figured a specimen from the Chipola Formation (Vokes, 1968, pl. 8, fig. 3) and we now have a total of six specimens from this formation. Most are small but Paul Drez, Albuquerque, New Mexico, collected one specimen at locality TU 951 that measures 41 mm in height. Jung (1965, pl. 69, figs. 8, 10) figured it from the correlative Early Miocene Cantaure Formation, Venezuela.

The species occurs in some numbers in the Plio-Pleistocene Pinecrest Beds [=

Fruitville Formation], and the Jackson Bluff, Tamiami, and Caloosahatchee formations of Florida. Woodring (1970, pl. 63, figs. 18, 19) figured it from the Gatun Formation, Panama. In the Gibson Smith Collection at the Naturhistorisches Museum, Basel, there is an example from the Mataruca Member, Caujaro Formation, Venezuela (pl. 17, fig. 3). The most unexpected occurrence is a specimen collected by James and Judith Terry Smith, from the Late Miocene Boleo Formation, north of Santa Rosalia, Baja California Sur, Mexico (pl. 17, fig. 4).

Though recorded as fossil from Florida to Venezuela and Baja California, from Early Miocene to Late Pliocene, the species disappeared leaving no modern descendant. The only living forms are *"Murex" exquisitus* Sowerby, 1904, believed to be from South Africa (Houart, 1980) and the distantly related *"Murex" tatei* Verco, 1895, from southern Australia.

In 1968 I noted that none of the many specimens in our collections had the nuclear whorls preserved. Finally, in material from Sarasota, Florida (TU 1000), collected by Mrs. Susan B. Stephens, one juvenile with well preserved nuclear whorls (pl. 17, fig. 2) shows that the protoconch consists of two and one-half large, bulbous whorls.

Genus HOMALOCANTHA Mörch, 1852

Homalocantha MÖRCH, 1852, Cat. Conch. Yoldi., pt. 1, p. 95.

Type species: *Murex scorpio* Linnaeus, 1758, by monotypy.

HOMALOCANTHA CRISPANGULA (Heilprin)
Plate 18, figure 1

Murex larvaecosta HEILPRIN, 1886, Wagner Free Inst. Sci., Trans., v. 1, p. 106, pl. 15, fig. 37.

Murex crispangula HEILPRIN, 1886, Wagner Free Inst. Sci., Trans., v. 1, p. 107, pl. 15, fig. 38.

Chicoreus larvaecosta (Heilprin). DALL, 1915, U.S. Natl. Mus., Bull. 90, p. 75.

Chicoreus crispangula (Heilprin). DALL, 1915, U.S. Natl. Mus., Bull. 90, p. 75, pl. 5, fig. 14.

Murex (Chicoreus) larvaecosta Heilprin. MANSFIELD, 1937, Florida Geol. Surv., Bull. 15, p. 129, pl. 5, fig. 9.

Murex (Chicoreus) crispangula Heilprin. MANSFIELD, 1937, Florida Geol. Surv., Bull. 15, p. 130.

Murexiella (Murexiella) crispangula (Heilprin). VOKES, 1968, Tulane Stud. Geol., v. 6, no. 3, p. 107, pl. 6, fig. 1.

Murexiella crispangula (Heilprin). VOKES, 1985, Malac. Soc. Australia, Jour., v. 7, nos. 1-2, p. 68, pl. 1, fig. 6.

Homalocantha crispangula (Heilprin). VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 67.

Description: "Shell strongly angulated, markedly rugose; spire elevated, of about five volutions; varices six (on the body whorl), sharp, deflected obliquely toward the base of the shell; surface of shell very strongly lined, the lines of three series, primary, secondary, and tertiary; those of the first series about ten on the body whorl, very prominently elevated on the varices, becoming spinose toward the base of the shell and on the apertural varix; aperture slightly exceeding one-half the length of shell, the very narrowly-contracted canal gently deflected." (Heilprin, 1886)

Holotype: Wagner Free Institute Sci. 867; height 1.6 inches [40.6 mm], diameter 0.7 inches [17.8 mm] (*fide* Heilprin, 1886, p. 107).

Type locality: Tampa Limestone; Ballast Point, Tampa Bay, Hillsborough County, Florida.

Occurrence: Tampa Limestone, Florida.

Figured specimen: USNM 214442; height 42.5 mm, diameter 24.0 mm; locality, Ballast Point, Tampa Bay, Hillsborough County, Florida.

Discussion: As discussed previously (Vokes, 1968, p. 108), the two forms named *Murex larvaecosta* and *Murex crispangula* by Heilprin represent the same species, and as "first reviser" I selected the name *"crispangula"* as more descriptive of the taxon, placing it in the genus *Murexiella*.

At the same time, I noted a close relationship between the two Florida species, *M. crispangula* and *M. calhouensis*, and the living eastern Pacific species referred to the genus *Homalocantha*. With more material available for study, it now appears that *Homalocantha* is older than originally believed and these western Atlantic species are *bona fide* members of *Homalocantha*.

HOMALOCANTHA CALHOUNESIS (Vokes)
Plate 18, figures 2-4

Murexiella (Murexiella) calhounensis VOKES, 1968, Tulane Stud. Geol., v. 6, no. 3, p. 110, pl. 5, fig. 4.

Homalocantha calhounensis (Vokes). VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 67.

Description: "Early whorls of holotype worn but embryonic shell apparently 1 1/2 smooth bulbous whorls, five post-nuclear whorls. Spiral sculpture on early whorls of two strong ribs alternating with three secondary riblets; on body whorl five strong spiral ribs with two more on extended siphonal canal. Between each pair of major spirals a single secondary riblet flanked by a tertiary thread on either side. Axial ornamentation on first post-nuclear whorl consisting of about ten small varices, reduced to eight on second post-nuclear whorl and to seven on each succeeding whorl. Where each spiral element crosses the varices pointed spines produced, proportional to the rank of the spiral rib; that spine at the shoulder only slightly stronger than the others. Numerous small axial growth lines crossing the spiral ornamentations give a scabrous appearance to entire shell surface. Aperture broken but probably round and almost entire; siphonal canal long and straight, not recurved at distal end." (Vokes, 1968)

Holotype: USNM 645891; height 31.9 mm, diameter 17.7 mm.

Type locality: TU 555, Chipola Formation; east bank of Chipola River about 1000 ft. above the mouth of Fourmile Creek (SW 1/4, Sec. 29, T1N, R9W), Calhoun County, Florida.

Occurrence: Chipola Formation, Florida.

Figured specimens: Fig. 2, USNM 482053; height 44.1 mm, diameter 23.0 mm; locality TU 547. Fig. 3, USNM 645891 (holotype). Fig. 4, USNM 482054; height (incomplete) 19.7 mm, diameter 18.8 mm; locality TU 830. Additional locality: TU 818.

Discussion: When described, the aperture of *H. calhounensis* was not known, but additional material shows it as typical of the group, almost circular, with an entire margin. The siphonal canal is more elongate than previously supposed, and in some examples the varical spines become extremely long (see pl. 18, fig. 4). Although described as *Murexiella,* the almost disjunct nature of the whorls, and especially the smooth "pad" at the posterior end of the columellar lip, indicates placement in the closely related genus *Homalocantha.*

The entire specimen shown in pl. 18, figure 2 was collected by Mr. Paul Drez, Albuquerque, New Mexico, who generously gave the specimen to me for study and illustration.

HOMALOCANTHA species
Plate 18, figure 5

Homalocantha species. VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 66, pl. 8, fig. 10.

Figured specimen: USNM 323899; height (incomplete) 15.4 mm, diameter (incomplete) 10.9 mm; locality TU 1249.

Discussion: From a small outcrop of middle Miocene age sediments in the southern Dominican Republic we have collected a single incomplete example of an unusual species of *Homalocantha.* It most nearly resembles the Indo-Pacific *H. zamboi* (Burch and Burch, 1960) but the specimen is too incomplete to do more than report its occurrence. However, the presence of a form with this morphology should be noted.

Genus FAVARTIA Jousseaume, 1880

Subgenus FAVARTIA s.s.

Favartia JOUSSEAUME, 1880, Le Naturaliste, Année 2, no. 42, p. 335.

PLATE 18

Figures Page

1. *Homalocantha crispangula* (Heilprin) 119
(X 1 1/2) USNM 214442; height 42.5 mm, diameter 24.0 mm.
Locality: Tampa Bay, Florida. Tampa Limestone.

2-4. *Homalocantha calhounensis* (Vokes) 119

2. (X 1 1/2) USNM 482053; height 44.1 mm, diameter 23.0 mm.
Locality: TU 547, Chipola River, Florida. Chipola Formation.

3. (X 1 1/2) USNM 645891 (holotype); height 31.9 mm, diameter 17.7 mm.
Locality: TU 555, Chipola River, Florida. Chipola Formation.

4. (X 2) USNM 482054; height (incomplete) 19.7 mm, diameter 18.8 mm.
Locality: TU 830, Tenmile Creek, Florida. Chipola Formation.

5. *Homalocantha* species 120
(X 3) USNM 323899; height (incomplete) 15.4 mm, diameter (incomplete) 10.9 mm.
Locality: TU 1249, San Cristobal, Dominican Republic. Unknown formation.

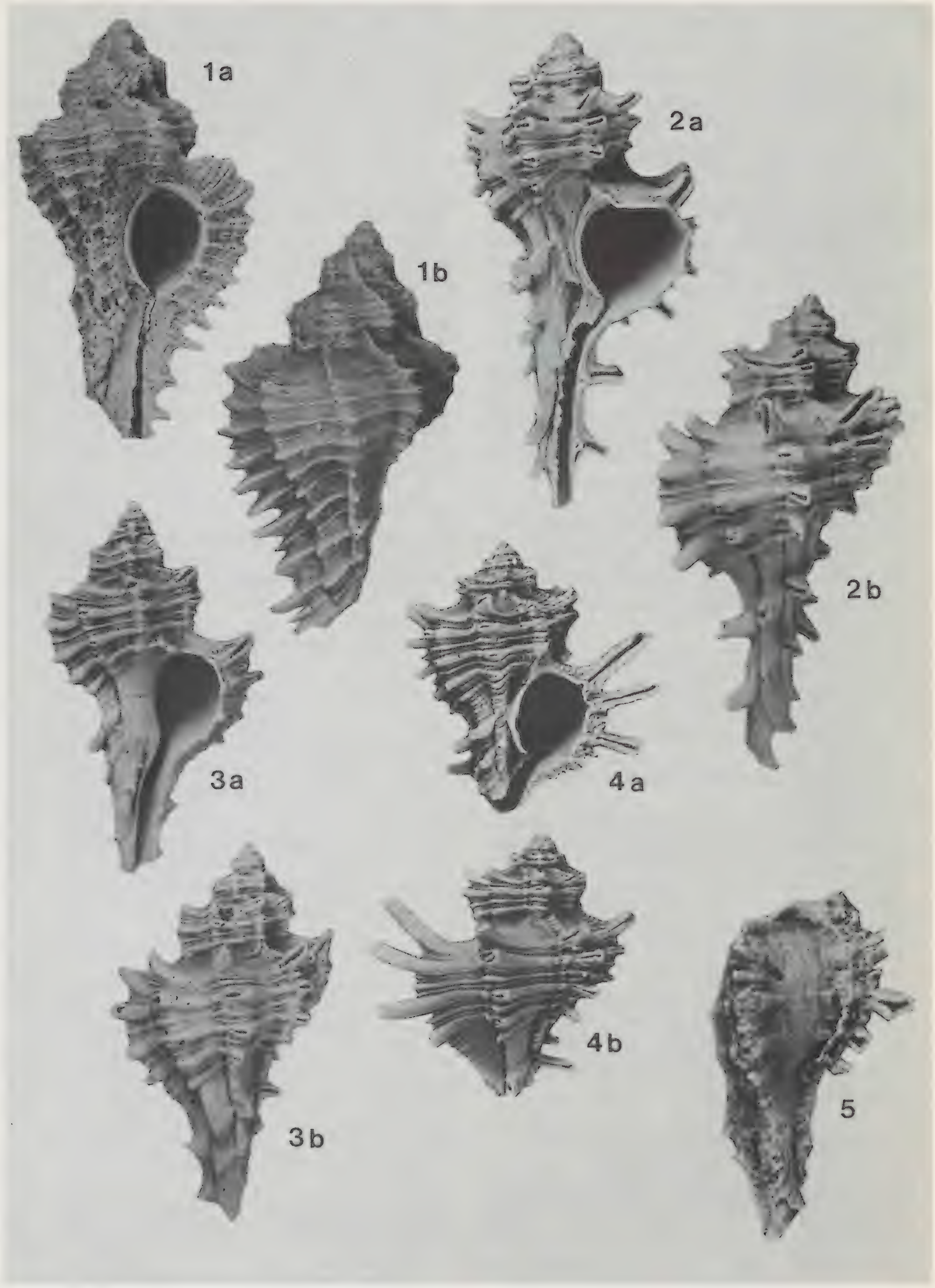

PLATE 18

Type species: *Murex breviculus* Sowerby, 1841, by original designation.

Discussion: In the Mio-Pliocene of Europe there are three named species of *Favartia: "Murex" suboblongus* d'Orbigny, 1852 (= *Murex oblongus* Grateloup, 1833, *non M. oblongus* Brocchi, 1814); *"Murex" kostejana* Boettger, 1901, and *"Murex" peyroti* Montanaro, 1935. Considering the variability of the species of this genus in America it is probable that all three represent a single biologic species.

The earliest records of this European form (pl. 19, fig. 3) are from the middle Miocene beds of France, Italy, Austria, and Hungary. It persists through the Pliocene in Italy but then disappears. Presumably, *Favartia cyclostoma* (Sowerby, 1841) (pl. 21, fig. 6) and other similar Indo-Pacific species are its living descendants. The New World species *F. cellulosa* and *F. nuceus* presumably also are descended from this ancestral form, as it has characters in common with both: the overall outline in *F. cellulosa* and the filigreed ornamentation in *F. nuceus*.

Favartia (Favartia) species
Plate 19, figure 1

Favartia (Favartia) species. VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 71, pl. 8, fig. 13.

Occurrence: Cercado and Gurabo formations; Dominican Republic.

Figured specimen: USNM 323902; height 6.4 mm, diameter 3.9 mm; locality TU 1230. Additional locality: TU 1227A.

Discussion: In our collections from the Dominican Republic there are two immature specimens (one each from TU 1230 and TU 1227A), which are totally unlike any other species of *Favartia*. As both specimens are juveniles the species was not named, but as the oldest occurrence of the genus in the New World, it is important to record this form.

Favartia (Favartia) zalaya Vokes
Plate 19, figure 2

Favartia (Favartia) zalaya VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 70, pl. 8, fig. 12.

Description: "Shell with five post-nuclear whorls and a protoconch of one-and-one-half smooth, bulbous turns. Spiral ornamentation initially of two strong cords, gradually developing a median groove and intercalating a smaller cord between each major pair; adult body whorl with six strong flattened cords, alternating with weaker threads; an additional two strong cords on the siphonal canal. Axial ornamentation on first post-nuclear whorl of 10 small laminae, gradually diminishing in number but increasing in strength; adult body whorl ornamented by six rounded varices. Adapertural face of the varices covered by minute laminae, looping outward on the spiral cords, giving a scabrous appearance to the shell. Spire high, approximately 60% of total height; suture undulated by varices but not impressed. Aperture rounded; outer lip bearing several weak, paired, lirations within; inner lip smooth, free-standing in advance of the aperture. Siphonal canal broad, very short, recurved at distal end; umbilicus formed by scale-like terminations of former canals." (Vokes, 1989)

Holotype: USNM 323901; height 8.0 mm, diameter 4.6 mm.

Type locality: TU 1227A, Gurabo Formation; Arroyo Zalaya, which crosses the road to Jánico from Santiago de los Caballeros, 11 km south of the bridge over the Río Yaque del Norte at Santiago, Dominican Republic.

Occurrence: Gurabo Formation, Dominican Republic.

Figured specimen: USNM 323901 (holotype).

Discussion: As discussed in the description of this small species, it is presumed ancestral to the Recent *F. minirosea* (Abbott), and demonstrates the development of that rather atypical species from the more typical *Favartia* morphotype.

Favartia (Favartia) cellulosa (Conrad)
Plate 20, figures 1-7
Plate 21, figures 1-5

Murex cellulosa CONRAD, 1846, Acad. Nat. Sci. Phila., Proc., v. 3, p. 25.

Murex jamaicensis G.B. SOWERBY, II, 1879, Thes. Conch., v. 4, *Murex*, pl. 23, fig. 223.

Ocinebra (Favartia) cellulosa (Conrad). DALL, 1889, Harvard Mus. Comp. Zool., Bull., v. 18, p. 210 only, not pl. 16, fig. 1 [= *Murexiella levicula* (Dall)]; DALL, 1890, Wagner Free Inst. Sci., Trans., v. 3, pt. 1, p. 150.

Ocinebra (Favartia) (intermedia Adams var.?) *alta* DALL, 1890, Wagner Free Inst. Sci., Trans., v. 3, pt. 1, p. 150.

Murex (Favartia) cellulosus Conrad. DALL and SIMPSON, 1901, U.S. Fish Comm., Bull., v. 20, pt. 1, p. 408; COSSMANN, 1903, Essais Paléoconch. Comp., v. 5, p. 30; CLENCH and PÉREZ FARFANTE, 1945, Johnsonia, v. 1, no. 17, p. 53, pl. 27, figs. 5-8; OLSSON

and HARBISON, 1953, Acad. Nat. Sci. Phila., Mon. 8, p. 245, pl. 36, figs. 6, 6a; ABBOTT, 1954, Amer. Seashells, p. 204 (in part), not fig. 45b [= *Murexiella levicula* (Dall)]; PERRY and SCHWENGEL, 1955, Marine Shells West Coast Florida, p. 155, pl. 31, fig. 217; WARMKE and ABBOTT, 1961, Caribbean Seashells, p. 106, fig. 19f; RADWIN and WELLS, 1968, Bull. Mar. Sci., v. 18, no. 1, p. 72, text-figs. 4 (radula), 17 (borehole), and 20-F (shell); RIOS, 1970, Coastal Brazilian Seashells, p. 79; HUMFREY, 1975, Sea Shells of the West Indies, p. 136 (in part), not pl. 16, fig. 4 [= *Murexiella macgintyi* (Smith)].

Ocinebra (intermedia Adams var.?) *alta* Dall. SCHUCHERT *et al.*, 1905, U.S. Natl. Mus., Bull. 53, p. 449.

Tritonalia cellulosa (Conrad). M. SMITH, 1939, Illus. Cat. Recent Species Rock Shells, p. 16, pl. 12, fig. 16 (SMITH, 1953, *ibid.*); PERRY, 1940, Bulls. Amer. Paleontology, v. 26, no. 95, p. 143, pl. 31, fig. 217; GARDNER, 1948, U.S. Geol. Surv., Prof. Paper 199, p. 219, pl. 29, fig. 16.

Tritonalia nuceus (Mörch). M. SMITH, 1939, Illus. Cat. Recent Species Rock Shells, p. 16, pl. 12, fig. 19 (SMITH, 1953, *ibid.*) (*not* of Mörch).

Murex (Favartia) cellulosus nuceus Mörch. RIOS, 1970, Coastal Brazilian Seashells, p. 79, pl. 21; HUMFREY, 1975, Sea Shells of the West Indies, p. 136 (in part), pl. 16, fig. 5 (*not* of Mörch).

Favartia cellulosa (Conrad). ABBOTT, 1974, Amer. Seashells (ed. 2), p. 187 (in part), not fig. 1953 [= *F. nuceus* (Mörch)]; KAICHER, 1974, Card Catalogue World-wide Shells, pack 6, Muricidae – Part II, no. 516; RIOS, 1975, Brazilian Marine Moll. Icon., p. 86, pl. 25, fig. 355; RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 146, pl. 24, figs. 4, 5 only [fig. 6 = *F. nuceus*]; FAIR, 1976, The Murex Book, p. 30, pl. 20, fig. 298; ABBOTT and DANCE, 1982, Compendium Seashells, p. 144 (in part), not color fig. [= *F. nuceus*]; RIOS, 1985, Seashells of Brazil, p. 85, pl. 30, fig. 272 (lower fig. only; upper fig. = *F. nuceus*); VOKES, 1985, Conch. Amer., Bull., v. 13, no. 2, p. 32, pl. 3, figs. 27, 28; PETUCH, 1988, Neogene Hist. Trop. Amer. Moll., p. 152, pl. 29, fig. 8; DE JONG and COOMANS, 1988, Stud. Fauna Curaçao, Caribbean Islands, v. 49, p. 73 (including *F. nuceus* in synonymy); HOUART, 1991, Nautilus, v. 105, no. 1, p. 31.

Favartia (Favartia) cellulosa (Conrad). VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 214.

Description: "Short-fusiform, with large, prominent revolving lines or costae, the interstices with transverse wrinkled lines, largest on the varices, and giving the shell a cellular aspect; beak much curved; color cinereous; aperture small, obovate, purplish within." (Conrad, 1846)

Holotype: Not found (not at ANSP, Nancy W. Rulon, letter, 1970).

Type locality: Tampa Bay, Hillsborough County, Florida.

Occurrence: Duplin Formation, North Carolina (*fide* Gardner, 1948, p. 219); Waccamaw Formation, South Carolina; Pinecrest Beds [= Fruitville Formation], Tamiami, Caloosahatchee, and Bermont formations, Florida; Holocene, Louisiana; Recent, from Bermuda to Espírito Santo, Brazil.

Figured specimens: PLATE 20. Fig. 1, USNM 482056; height 21.9 mm, diameter 12.6 mm; locality TU 1000. Fig. 2, USNM 482057; height 20.2 mm, diameter 12.3 mm; locality TU 1000. Fig. 3, USNM 112180 (lectotype – *Ocinebra alta* Dall); height 17.4 mm, diameter 10.0 mm; locality, Ft. Denaud, Lee County, Florida (= TU 203). Fig. 4, USNM 112178 (paralectotype – *Ocinebra alta* Dall); height 24.6 mm, diameter 12.3 mm; locality, Shell Creek, Charlotte County, Florida (= TU 539B). Fig. 5, USNM 482058; height 21.7 mm, diameter 12.0 mm; locality TU 974. Fig. 6, USNM 482059; height 18.8 mm, diameter 12.0 mm; locality TU 523. Fig. 7, USNM 482060; height 16.5 mm, diameter 10.5 mm; locality TU 803. PLATE 21. Fig. 1, USNM 880020; height 21.0 mm, diameter 12.8 mm; locality, Johns Pass, Pinellas County, Florida, 50 meters. Fig. 2, USNM 880021; height 15.3 mm, diameter 9.0 mm; locality, Johns Pass, Pinellas County, Florida, 50 meters. Fig. 3, USNM 880022; height 17.3 mm, diameter 9.7 mm; locality, Tea Table Key, Monroe County, Florida. Fig. 4, USNM 880023; height 21.2 mm, diameter 14.5 mm; locality TU 977. Fig. 5, USNM 880024; height (incomplete) 15.5 mm, diameter 10.5 mm; locality TU 977. Additional localities: TU 68, 201, 202, 203, 529A, 529B, 536, 539A, 539B, 558, 580, 726, 727, 759, 767, 768, 791, 797, 816, 933, 975, 978, 991, 1175, 1177, 1491, 1512, 1524.

Discussion: Favartia cellulosa first appears in the mid-Pliocene beds of southern Florida: in the Tamiami facies (localities TU 1175, 1177) and in the Pinecrest Beds (TU 797, 933, 1000, 1491, 1524). The mid-Pliocene form is very like the living shell (pl. 20, figs. 1, 2), but a different morphotype appears at many localities in the Caloosahatchee Formation. This latter form, more elongate than the typical species, was given the name *"Ocinebra" alta* by Dall (1890, p. 150).

It is evident from the treatment accorded *"Ocinebra" cellulosa, levicula, intermedia,*

and *alta* by Dall (1889, pp. 210-211; 1890, p. 150) that he did not understand the group. As noted above under the genus *Murexiella,* there is a marked degree of similarity between *Favartia* and *Murexiella* (where *levicula* is now placed) but one certainly has no difficulty distinguishing the two species. Likewise, there is a strong similarity between *Favartia* s.s. and the subgenus *Caribiella* (where *intermedia [i.e., alveata]* is now placed) but, again, the species are easily separable.

There is an additional problem with *"Ocinebra" alta,* as Schuchert *et al.,* (1905, p. 449) evidently selected the wrong specimen for a lectotype of the species. In the type lot of *"Ocinebra" alta,* at the U.S. National Museum, there are three adult specimens and ten juveniles. One of these specimens (USNM 112178, from Shell Creek, pl. 20, fig. 4) matches the dimensions cited by Dall in his table of comparison between *cellulosa, intermedia,* and *alta* (1890, p. 150). In my opinion, this specimen should have been selected as lectotype. But, instead, a different shell (USNM 112180, from Ft. Denaud, pl. 20, fig. 3) was selected by Schuchert *et al.* as the lectotype. This specimen does not even have an elongated form but is a typical *F. cellulosa.*

In general, the Pliocene examples of *F. cellulosa* are more elongate than the living ones. But, in the Recent fauna there are tall specimens and short specimens, fat ones and thin ones, examples with five varices and those with as many as eight varices. Some are rounded (pl. 21, fig. 3), some elaborately varixed (pl. 21, fig. 4). In truth, there are so many variations in the living fauna, commonly occuring at the same locality, that neither the fossil nor the Recent variations are worthy of separation.

This, the most widespread of the American *Favartia* species, ranges from Bermuda (Castle Harbour, Bermuda) to Florida and the Gulf of Mexico, Dominican Republic (TU-R 326), and St. Croix (TU R-318) to Brazil. Rios (1970, p. 79; 1975, p. 86) records occurrences as far south as Rio Grande do Norte and Houart (1991, p. 31) extends the range to Espírito Santo. I have no knowledge of specimens from Central America or northern South America.

The depth of occurrence also is wide ranging. Most specimens are taken intertidally on mussel beds; but there are examples dredged from 50 meters at Johns Pass (west of St. Petersburg), Florida (pl. 21, figs. 1, 2), and we have beautiful speci-

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PLATE 19

Figures Page

1. *Favartia (Favartia)* species 122
(X 7) USNM 323902; height 6.4 mm, diameter 3.9 mm.
Locality: TU 1230, Río Cana, Dominican Republic. Cercado Formation.
2. *Favartia (Favartia) zalaya* Vokes 122
(X 6) USNM 323901 (holotype); height 8.0 mm, diameter 4.6 mm.
Locality: TU 1227A, Arroyo Zalaya, Dominican Republic. Gurabo Formation.
3. *Favartia (Favartia) suboblonga* (d'Orbigny) 122
(X 3) NMB H 17471; height 15.8 mm, diameter 10.0 mm.
Locality: Pontlevoy, France. Helvetian.
4. *Favartia (Favartia) micromeris* Dall 128
(X 6) USNM 482055; height 7.3 mm, diameter 4.6 mm.
Locality: TU 529B, Caloosahatchee River, Florida. Caloosahatchee Formation.
5-7. *Favartia (Favartia) minirosea* (Abbott) 128
5. (X 6) USNM 880017; height 7.3 mm, diameter 4.0 mm.
Locality: TU R-99, off Quintana Roo, Mexico. Recent.
6. (X 6) USNM 880018; height 9.0 mm, diameter 5.4 mm.
Locality: off Cedar Key, Florida. Recent.
7. (X 6) USNM 880019; height 7.1 mm, diameter 4.0 mm.
Locality: off Egmont Key, Florida. Recent.

PLATE 19

mens (pl. 21, fig. 4) in the material from "Mudlump 90," at the mouth of South Pass, Mississippi River delta (TU 977), in beds estimated to have been deposited in 60 meters depth (Morgan *et al.*, 1963, p. 41).

In my Catalogue of the genus *Murex* (Vokes, 1971a, p. 99) I placed *Murex solidus* Adams, 1853 (*non* Anton, 1839), from West Africa, in synonymy with *F. cellulosa*, based on the Sowerby illustration (1879, pl. 24, fig. 246). However, examination of Adams's type in the British Museum (Natural History) shows the former species to be the same as *F. burnayi* Houart, 1981, from the Cape Verde Islands.

FAVARTIA (FAVARTIA) PACEI Petuch
Plate 23, figures 1-4

Favartia pacei PETUCH, 1988, Neogene Hist. Trop. Amer. Moll., p. 152, pl. 29, figs. 6, 7.

Description: "Shell stocky, biconic in form, broad across shoulder; spire elevated, turriculate; 8-9 thin, spinose varices per whorl; shoulder very sharply angled, single large, recurved spine on each varix at shoulder angle, giving shell vaselike appearance; body whorl ornamented with 6-8 heavily fimbriated spiral cords; cords intersect varices, producing small, recurved spine at each juncture; siphonal canal very short, poorly developed, with 2-3 heavily fimbriated spiral cords, shell color white with 2 large brown blotches showing through fimbriations behind each varix; interior of aperture pale whitish-cream with 2 rows of large, dark brown patches." (Petuch, 1988)

Holotype: USNM 859940; height 16.2 mm, diameter 11.8 mm.

Type locality: Off Harry Harris State Park, Key Largo, Monroe County, Florida.

Occurrence: Bermont Formation, Florida (*fide* Petuch, 1988, p. 155); Recent, southern Florida.

Figured specimens: Fig. 1, USNM 859940 (holotype). Fig. 2, USNM 880028; height 16.0, diameter 10.6 mm; locality, Tea Table Key, Monroe County, Florida. Fig. 3, USNM 880029; height 12.3 mm, diameter 9.0 mm; locality, Johns Pass, Pinellas County, Florida, 50 meters. Fig. 4, USNM 880030; height 12.8 mm, diameter 9.2 mm; locality, Stirup Key, Marathon, Monroe County, Florida.

Discussion: Petuch's description for this species is somewhat misleading, as he states the species has "8-9 thin, spinose varices per whorl." This is true only in the holotype, which has eight varices on the body whorl, nine on the penultimate and earlier whorls. Most specimens have six to eight varices, as does *F. cellulosa*. The two species are very difficult to distinguish and commonly occur together, for example at Tea Table Key (pl. 21, fig. 3 and pl. 23, fig. 2) and Johns Pass (pl. 21, figs. 1, 2, and pl. 23, fig. 3). Nevertheless, the differences between the two forms are consistent, with *F. pacei* more biconical in outline and *F. cellulosa* more oval. Both species live on the mussel beds and the presence of two similar species in an apparently identical environment remains unexplained.

PLATE 20

Figures Page

1-7. *Favartia (Favartia) cellulosa* (Conrad) 122

1. (X 3) USNM 482056; height 21.9 mm, diameter 12.6 mm.
   Locality: TU 1000, Sarasota, Florida. Pinecrest Beds.
2. (X 3) USNM 482057; height 20.2 mm, diameter 12.3 mm.
   Locality: TU 1000, Sarasota, Florida. Pinecrest Beds.
3. (X 3) USNM 112180 (lectotype – *Ocinebra alta* Dall); height 17.4 mm, diameter 10.0 mm.
   Locality: Ft. Denaud, Florida (= TU 203). Caloosahatchee Formation.
4. (X 2 1/2) USNM 112178 (paralectotype – *Ocinebra alta* Dall); height 24.6 mm, diameter 12.3 mm.
   Locality: Shell Creek, Florida (= TU 539B). Caloosahatchee Formation.
5. (X 3) USNM 482058; height 21.7 mm, diameter 12.0 mm.
   Locality: TU 974, Caloosahatchee River, Florida. Caloosahatchee Formation.
6. (X 3) USNM 482059; height 18.8 mm, diameter 12.0 mm.
   Locality: TU 523, Harney Pond Canal, Florida. Pinecrest Beds.
7. (X 3) USNM 482060; height 16.5 mm, diameter 10.5 mm.
   Locality: TU 803, Caloosahatchee River, Florida. Bermont Formation.

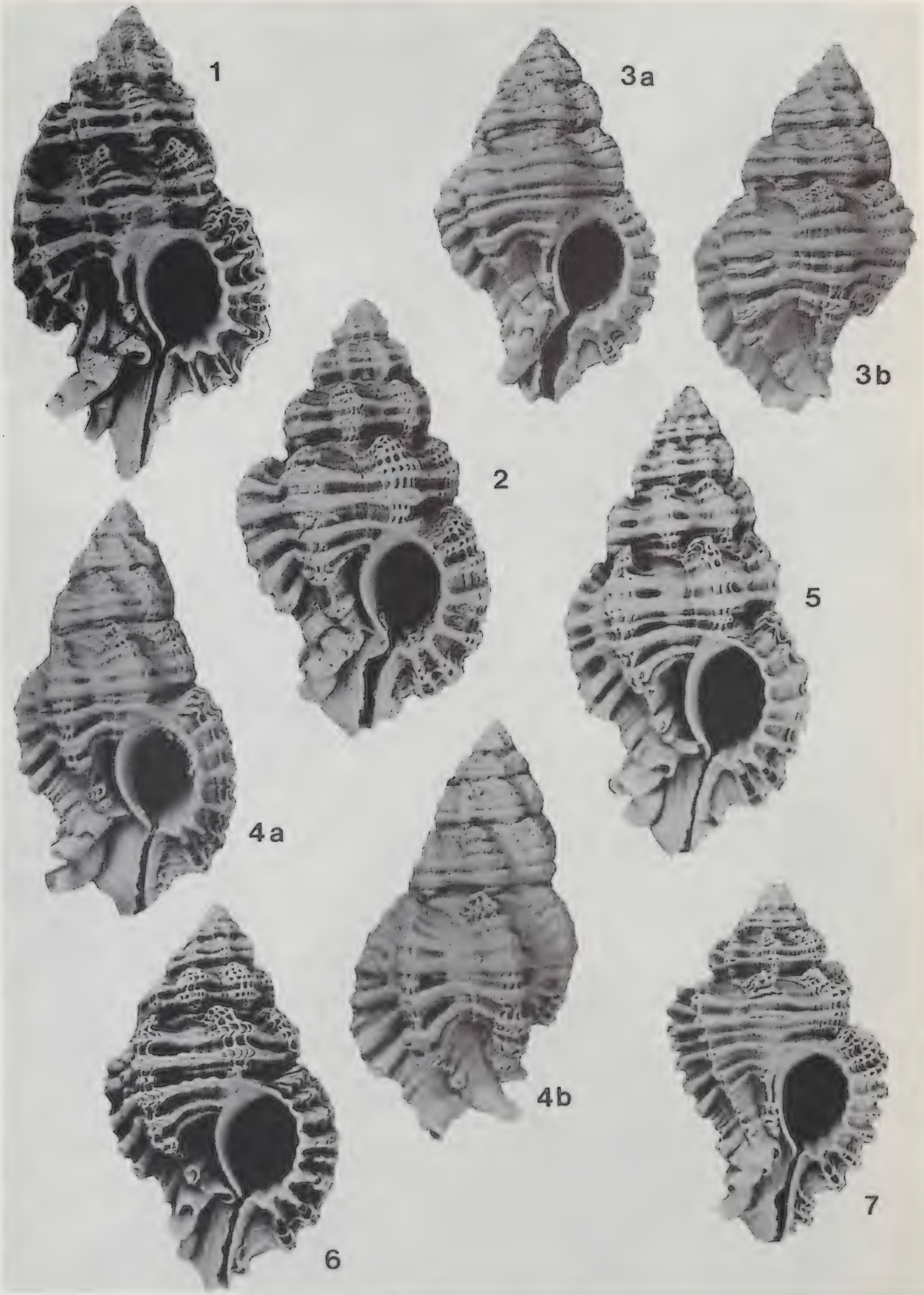

PLATE 20

FAVARTIA (FAVARTIA) MICROMERIS
(Dall)
Plate 19, fig. 4

Murex (Chicoreus?) micromeris DALL, 1890, Wagner Free Inst. Sci., Trans., v. 3, pt. 1, p. 141, pl. 12, fig. 12.

Murex (Phyllonotus) micromeris Dall. DALL and SIMPSON, 1901, U.S. Fish Comm., Bull., v. 20, pt. 1, p. 408 (in part), not pl. 53, fig. 17 [= *F. minirosea* (Abbott)].

Murex (Favartia) micromeris Dall. COSSMANN, 1903, Essais Paléoconch. Comp., v. 5, p. 30.

Ocenebra (Ocinebrina) micromeris (Dall). ABBOTT, 1954, Nautilus, v. 68, no. 2, p. 43.

Description: "Shell small, compact, with one and a half smooth nuclear and four subsequent sculptured whorls; transverse sculpture of (on the last whorl eight) rounded ribs continuous over the shell, with wider interspaces, and by incremental lines of which the edges are sometimes squamose, especially on the spirals; spiral sculpture of strong, elevated, granulose or slightly scaly threads with equal interspaces, strongest near the periphery and weaker in front of the suture; these number from three to six on the earlier whorls and on the last whorl are increased by intercalation; canal short, almost closed in front, with prominently squamose fasciole; aperture subcircular, with a thin, raised margin, smooth-edged on the inner or pillar-lip, crenulated by the sculpture and internally lirate on the opposite side; suture distinct, not channeled." (Dall, 1890)

Holotype: USNM 112164; height 7.5 mm, diameter 4.3 mm (*fide* Dall, 1890, p. 141).

Type locality: Caloosahatchee Formation; Caloosahatchee River, near Fort Thompson, Hendry County, Florida (Schuchert *et al.*, 1905, p. 420).

Occurrence: Caloosahatchee Formation, Florida.

Figured specimen: USNM 482055; height 7.3 mm, diameter 4.6 mm; locality TU 529B.

Discussion: This small species decribed from the Caloosahatchee Formation is rare. We have collected just two specimens, the one figured here (pl. 19, fig. 4), and a smaller one from the same locality (TU 529B).

Originally, Dall combined the Caloosahatchee species with a similar Recent form that, subsequently, was named *Ocenebra (Ocinebrina) minirosea*. It is this latter species that Dall and Simpson figured (1901, pl. 53, fig. 17) from the Recent fauna of Puerto Rico.

FAVARTIA (FAVARTIA) MINIROSEA
(Abbott)
Plate 19, figures 5-7

Murex coccineus A. ADAMS, 1854, Zool. Soc. London, Proc., pt. 21 (1853), p. 72; TRYON, 1880, Man. Conch., v. 2, p. 130, pl. 38, fig. 463; FAIR, 1976, p. 32, text-fig. 60 (after Tryon) (*non Murex coccineus* Lesson, 1844).

Murex (Chicoreus?) micromeris DALL, 1890, Wagner Free Inst. Sci., Trans., v. 3, pt. 1, p. 141 (in part), not pl. 12, fig. 12.

Murex (Phyllonotus) micromeris Dall. DALL and SIMPSON, 1901, U.S. Fish Comm., Bull., v. 20, pt. 1, p. 408 (in part), pl. 53, fig. 17.

Ocenebra (Ocinebrina) minirosea ABBOTT, 1954, Nautilus, v. 68, no. 2, p. 43, pl. 2, fig. 1; ABBOTT, 1974, Amer. Seashells (ed. 2), p. 184, text-fig. 1923 (after Dall and Simpson, 1901).

PLATE 21

Figures Page

1-5. *Favartia (Favartia) cellulosa* (Conrad) 122
1. (X 3) USNM 880020; height 21.0 mm, diameter 12.8 mm.
Locality: Johns Pass, Florida. Recent.
2. (X 3) USNM 880021; height 15.3 mm, diameter 9.0 mm.
Locality: Johns Pass, Florida. Recent.
3. (X 3) USNM 880022; height 17.3 mm, diameter 9.7 mm.
Locality: Tea Table Key, Florida. Recent.
4. (X 2 1/2) USNM 880023; height 21.2 mm, diameter 14.5 mm.
Locality: TU 977, Mississippi River Delta, Louisiana. Holocene.
5. (X 10) USNM 880024; height (incomplete) 15.5 mm, diameter 10.5 mm.
Locality: TU 977, Mississippi River Delta, Louisiana. Holocene.
6. *Favartia (Favartia) cyclostoma* (Sowerby) 122
(X 4) Natal Museum H 1325; height 11.8 mm, diameter 7.8 mm.
Locality: Conducia Bay, Mozambique. Recent.

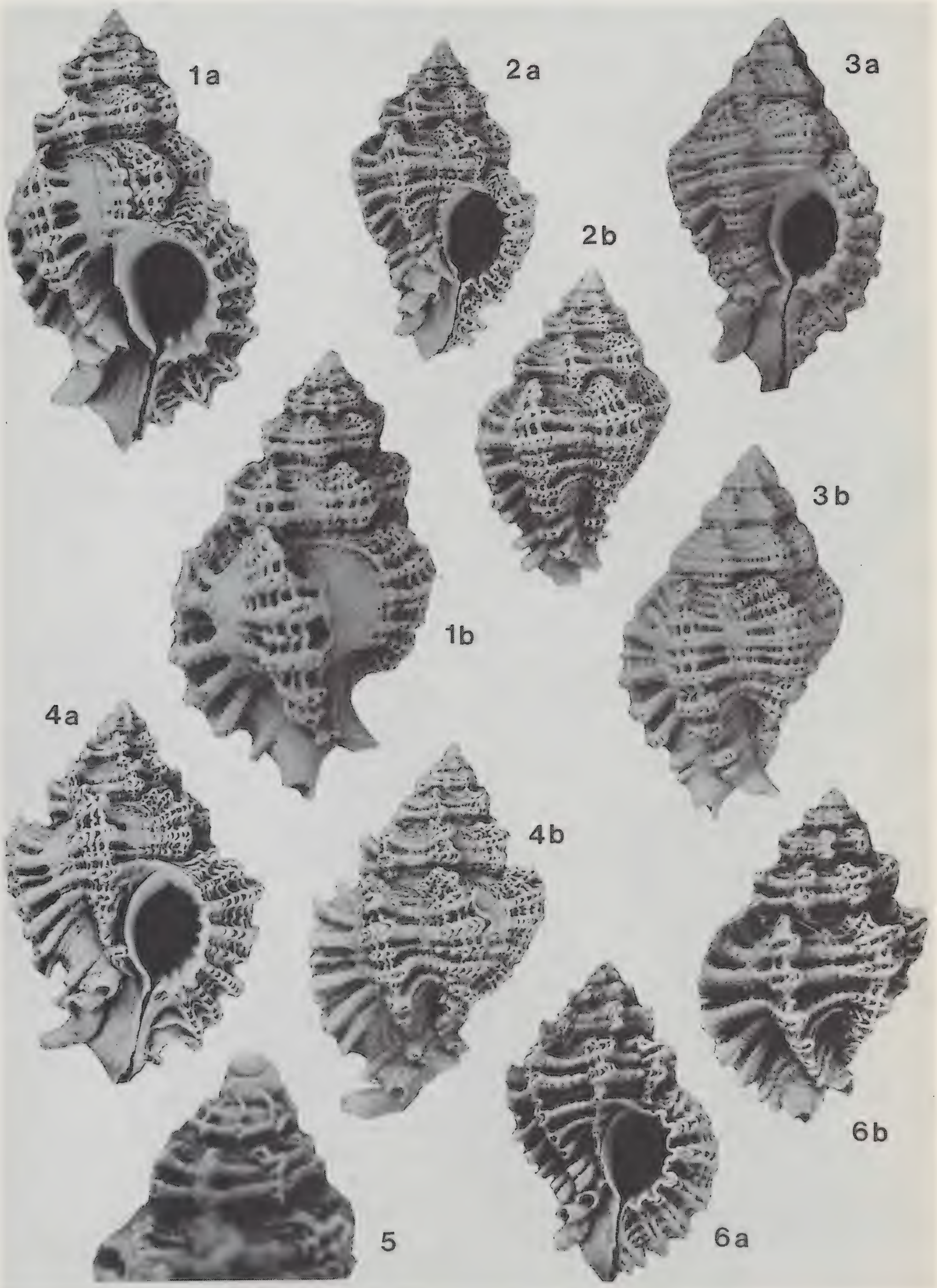

PLATE 21

Favartia minirosea (Abbott). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 151, pl. 29, fig. 16.

Ocenebra minirosea Abbott. FAIR, 1976, The Murex Book, p. 59, pl. 21, fig. 326 (holotype).

Favartia (Favartia) minirosea (Abbott). VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 214; VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 71.

Description: "Small, from 5 to 7 mm in length, elongate-fusiform; color all pink or yellowish tan with a pink or brownish pink aperture; 4 1/2 postnuclear whorls; last whorl with 7 to 9 rounded, axial ribs, the last of which forms a thickened varix; penultimate whorl with 9 to 11 similar ribs; spiral sculpturing consists of strongly raised, squarish cords which are crossed by distinct, crowded fimbriations. The latter are inclined to be fluted and raised into minute spine-like projections in the region of the axial ribs. The lowest cord, just above the ends of the former siphonal canals, bears 5 to 7 large, fluted scales. Last whorl with about 10 of these major spiral cords, but one or two much smaller fimbriated threads may occur between them. Nucleus with one smooth, glossy, pink or whitish whorl. Aperture oval; peristome almost complete and somewhat spout-like, with a thin, sharp inner and outer lip. Inside of outer lip with 5 or 6 weak, elongate teeth. Outer lip crenulate. Siphonal canal well developed, and almost closed along its length, except for a narrow slit. The ends of 3 or 4 siphonal canals show at the left." (Abbott, 1954)

Holotype: USNM 103380; height 7.5 mm, diameter 4.0 mm (specimen figured by Dall and Simpson, 1901).

Type locality: Jamaica, dredged by the *Albatross*, no station record.

Occurrence: Recent only, Gulf of Mexico and Greater Antilles.

Figured specimens: Fig. 5, USNM 880017; height 7.3 mm, diameter 4.0 mm; locality TU R-99. Fig. 6, USNM 880018; height 9.0 mm, diameter 5.4 mm; locality, off Cedar Key, Levy County, Florida, 30-35 meters. Fig. 7, USNM 880019; height 7.1 mm, diameter 4.0 mm; locality, off Egmont Key, Hillsborough County, Florida, 62 meters.

Discussion: The taxon *Murex coccineus* A. Adams, 1854, although described from St. Thomas, Virgin Islands, has never been included in the western Atlantic fauna, for two reasons: it was not figured and the name is pre-occupied. The only author to illustrate the species was Tryon (1880, p. 130, pl. 38, fig. 463), who figured a specimen that he said had been sent to him from the original locality. His illustration is very misleading, as the shell is enlarged three times (in the text Tryon states "Length, .3 inch"), but the size bar is placed so that it appears alongside the adjacent illustration. Therefore, at first glance, it appears to be a species of *Murexiella,* perhaps *M. levicula,* as suggested by Fair (1976, p. 32).

Fortunately, Tryon's material is still available in the collections of the Academy of Natural Sciences of Philadelphia, where there are two lots (ANSP 36207 [including the figured specimen, height 7.7 mm], ANSP 36186; collected by Swift), all of which are *F. minirosea.* As the name *Murex coccineus* is preoccupied, this identification is only of historic interest, but it should be noted.

Although Dall included the Caloosahatchee *F. micromeris* and the Recent *F.*

PLATE 22

Figures Page

1, 2. *Favartia (Favartia) nuceus* (Mörch) 132

1. (X 2) Bullis Collection; height 27.8 mm, diameter 17.5 mm.
Locality: *Oregon* Station 5679, off Guajira Peninsula, Colombia. Recent.
2. (X 3) USNM 880025; height 15.4 mm, diameter 10.9 mm.
Locality: off Guajira Peninsula, Colombia. Recent.

3. *Favartia (Favartia) incisa* (Broderip) 134
(X 2) USNM 880026; height 23.5 mm, diameter 14.1 mm.
Locality: TU R-188, Venado Island, Panama. Recent.

4-6. *Favartia (Favartia) lindae* Petuch 134

4. (X 5) USNM 859805 (holotype); height 11.2 mm, diameter 6.0 mm.
Locality: off Apalachicola, Florida. Recent.
5. (X 3) USNM 880027, height 16.2 mm, diameter 9.0 mm (not whitened, to show color pattern).
Locality: Sanibel, Florida. Recent.
6. (X 5; protoconch X 10) USNM 482061; height 8.5 mm, diameter 5.4 mm.
Locality: TU 978, South Bay, Florida. Bermont Formation.

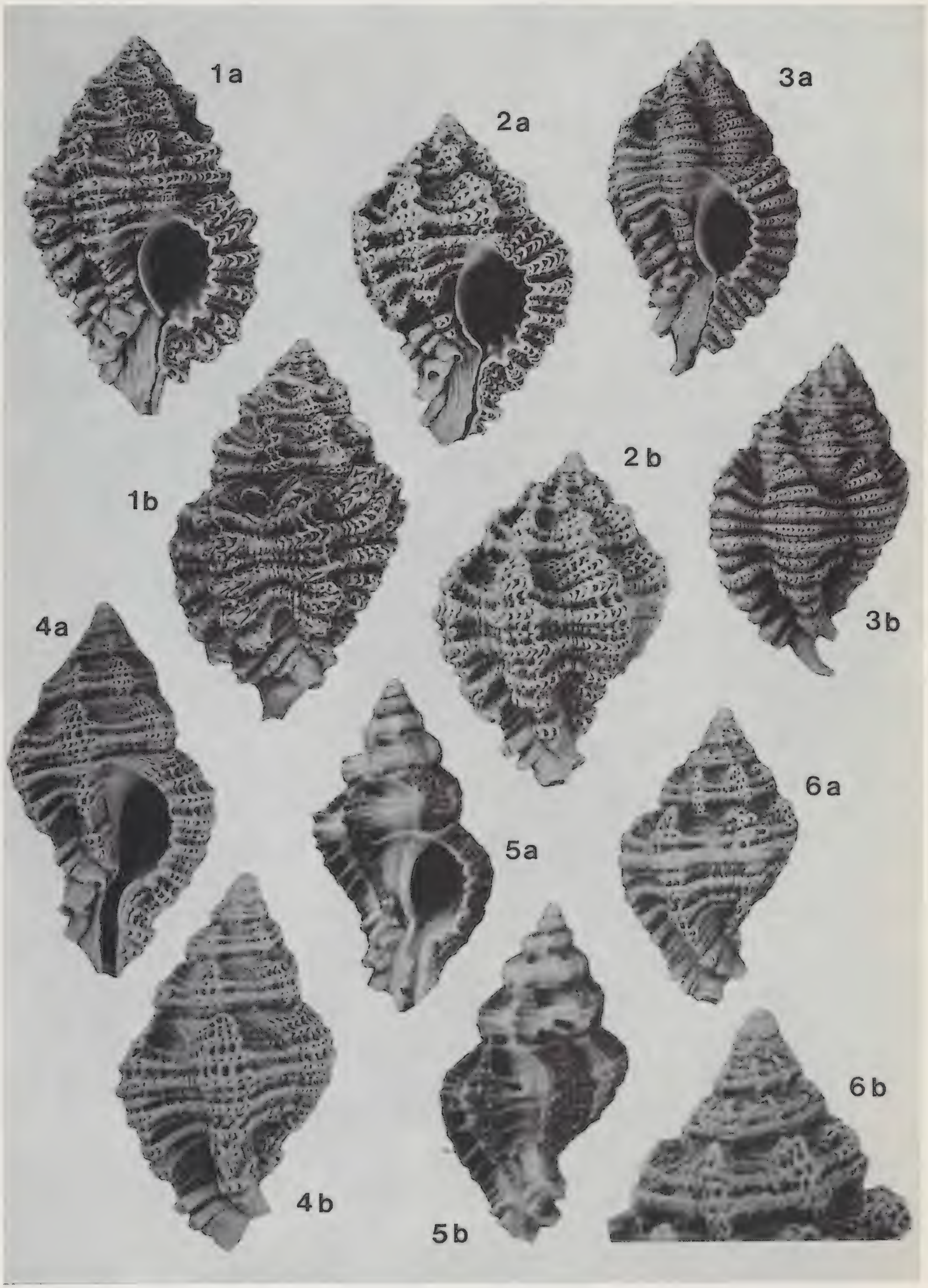

PLATE 22

minirosea in the same species, and Abbott, who separated them, considered *F. micromeris* ancestral to *F. minirosea*, it is more likely that the Dominican species, *F. zalaya* Vokes (pl. 19, fig. 2), is the ancestor of the living *F. minirosea*. All three share generic similarity and small size (maximum height under 10 mm) but *F. zalaya* and *F. minirosea* are both relatively elongate compared to the almost globular *F. micromeris*.

Also, it is probable that the Dominican and the Recent species share a somewhat deeper habitat. Radwin and D'Attilio (1976, p. 151) record *F. minirosea* from depths of 50 to 100 meters and in the Vokes Collection there are specimens ranging from 30 to 110 meters, averaging 67 meters. *Favartia micromeris* also may have been a deeper species, explaining its extreme rarity in the shallow-water Caloosahatchee Formation.

FAVARTIA (FAVARTIA) NUCEUS (Mörch)
Plate 22, figures 1, 2

Murex nuceus MÖRCH, 1850, Cat. Conch. Kierulf, p. 31, pl. 1, fig. 9.

Murex (Ocinebra) nuceus (Mörch). TRYON, 1880, Man. Conch., v. 2 (Muricinae, Purpurinae), p. 122, pl. 37, fig. 429.

Not *Tritonalia nuceus* (Mörch). SMITH, 1939, Illus. Cat. Recent Species Rock Shells, p. 16, pl. 12, fig. 19 (SMITH, 1953, *ibid.*) [= *F. cellulosa* (Conrad)].

Murex (Favartia) cellulosus nuceus Mörch. CLENCH and PÉREZ FARFANTE, 1945, Johnsonia, v. 1, no. 17, p. 54, pl. 28, figs. 4-6; ABBOTT, 1954, Amer. Seashells, p. 205, pl. 25, fig. i (same figure as Clench and Pérez Farfante, 1945, pl. 28, fig. 5); WARMKE and ABBOTT, 1961, Caribbean Seashells, p. 106, text-fig. 19g; BULLIS, 1964, Tulane Stud. Zoology, v. 11, no. 4, p. 107; RIOS, 1970, Coastal Brazilian Seashells, p. 79 (in part), not pl. 21 [= *F. cellulosa* (Conrad)]; HUMFREY, 1975, Sea Shells of the West Indies, p. 136 (in part), not pl. 16, fig. 5 [= *F. cellulosa* (Conrad)].

Favartia cellulosa (Conrad). ABBOTT, 1974, Amer. Seashells (ed. 2), p. 187 (in part), fig. 1953 (same figure as 1954, pl. 25, fig. i) ; RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 146 (in part), pl. 24, fig. 6 [not figs. 4, 5 = *F. cellulosa* (Conrad)]; ABBOTT and DANCE, 1982, Compendium Seashells, p. 144 (in part), color fig.; RIOS, 1985, Brazilian Marine Moll. Icon. p. 85, pl. 25, fig. 372 (upper fig. only; lower fig = *F. cellulosa*) (*not* of Conrad).

Favartia nuceus (Mörch). KAICHER, 1974, Card Catalogue World-wide Shells, pack 6, Muricidae – Part II, no. 562.

Favartia cellulosa nuceus (Mörch). RIOS, 1975, Brazilian Marine Moll. Icon., p. 87, pl. 25, fig. 356.

Favartia nucea (Mörch). FAIR, 1976, The Murex Book, p. 62, pl. 20, fig. 294 (Vokes photo).

Favartia (Favartia) nucea (Mörch). VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 214, pl. 2, fig. 12.

Description: "Shell small, from 20 to 25 mm in length and possessing five to six low, slightly oblique and fluted varices. Varices a little wider and heavier structurally than in *M. cellulosus*. In general, the shell is heavier and a little more globose than the typical species [*F. cellulosa*]. All specimens so far examined have a somewhat shorter siphonal canal." (Clench and Pérez Farfante, 1945)

PLATE 23

Figures Page

1-4. *Favartia (Favartia) pacei* Petuch 126
1. (X 3) USNM 859940 (holotype); height 16.2 mm, diameter 11.8 mm. Locality: Key Largo, Florida. Recent.
2. (X 3) USNM 880028; height 16.0 mm, diameter 10.6 mm. Locality: Tea Table Key, Florida. Recent.
3. (X 3) USNM 880029; height 12.3 mm, diameter 9.0 mm. Locality: Johns Pass, Florida. Recent.
4. (X 3) USNM 880030; height 12.8 mm, diameter 9.2 mm. Locality: Stirup Key, Florida. Recent.

5, 6. *Favartia (Favartia) barbarae* Vokes, n. sp 134
5. (X 3) USNM 880031 (holotype); height 21.0 mm, diameter 11.9 mm. Locality: off Río Lagartos, Yucatan, Mexico. Recent.
6. (X 3) USNM 880032 (paratype); height 19.8 mm, diameter 12.0 mm. Locality: same as holotype.

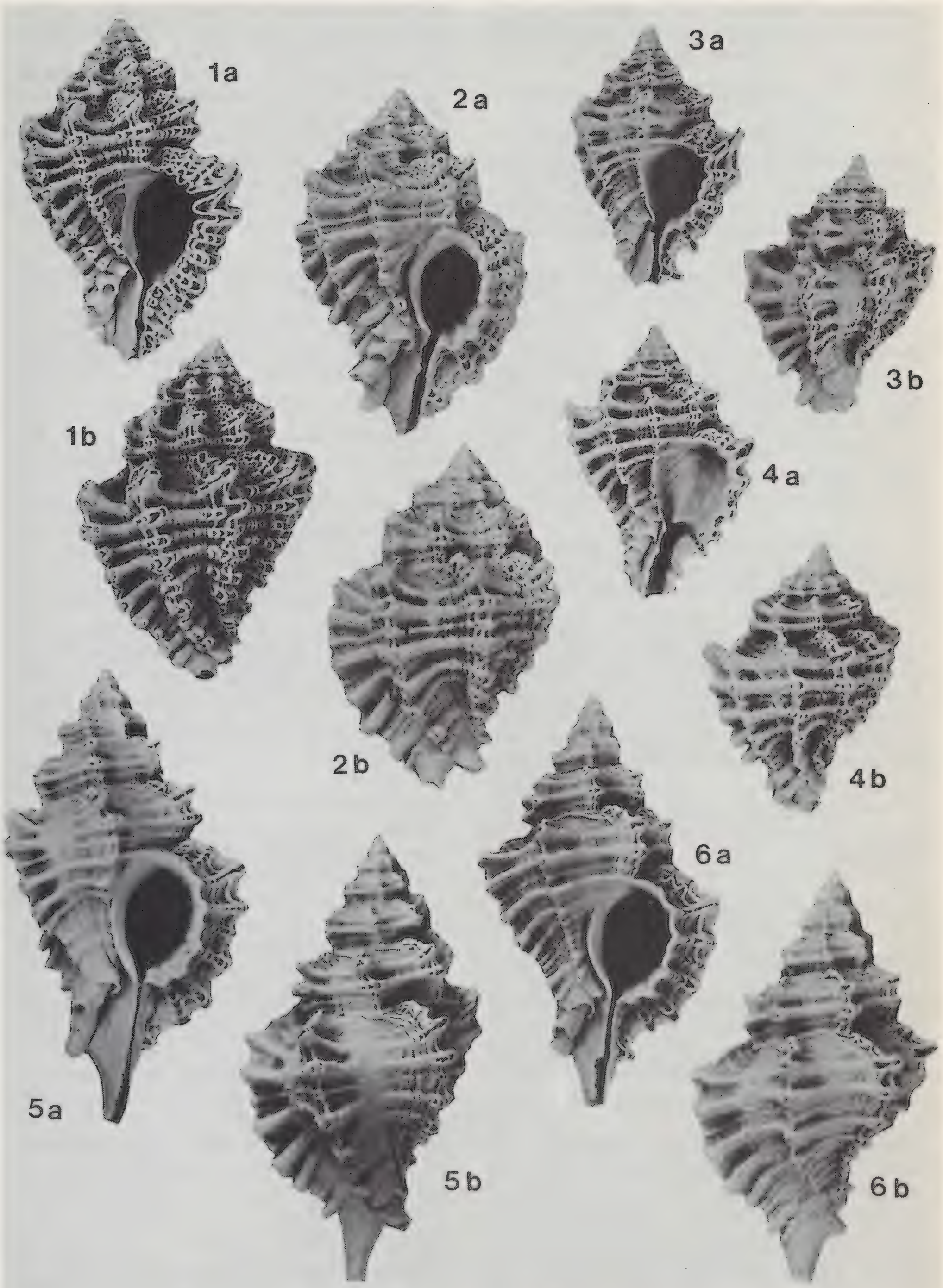

PLATE 23

Holotype: Not found.

Type locality: St. Thomas, U.S. Virgin Islands (designated by Clench and Pérez Farfante, 1945, p. 55).

Occurrence: Recent only, from Greater Antilles to Brazil.

Figured specimens: Fig. 1, Bullis Collection*; height 27.8 mm, diameter 17.5 mm; locality, *Oregon* Station 5679, off Guajira Peninsula, Colombia, 44 meters. Fig. 2, USNM 880025; height 15.4 mm, diameter 10.9 mm; locality, off Guajira Peninsula, Colombia.

Discussion: Many authors have synonymized *F. cellulosa* and *F. nuceus* and others have considered *F. nuceus* to be a geographic subspecies of *F. cellulosa*. I consider, however, the two forms to be distinct. *Favartia nuceus* is a larger species, most closely related to the eastern Pacific *F. incisa* (Broderip, 1833) (pl. 22, fig. 3); both are characterized by a globular shell, with elaborate filigree covering the spiral cords.

In a previous publication (Vokes, 1984, p. 214) I cited the name of this species as "*nucea*", as did Fair (1976, p. 62; probably upon my advice). However, the name "*nuceus*" (Latin – of a nut) is a noun and does not change gender to agree with the feminine genus *Favartia*.

As Clench and Pérez Farfante (1945, p. 55) stated, the illustration of *Murex jamaicensis* Sowerby, 1879, generally considered a synonym of *F. nuceus* (because of the locality, no doubt) is more elongate and is better referred to synonymy with *F. cellulosa*.

Favartia (Favartia) lindae Petuch

Plate 22, figures 4-6

Favartia lindae PETUCH, 1987, New Caribbean Moll. Faunas, p. 14, pl. 1, figs. 5, 6; PETUCH, 1988, Neogene Hist. Trop. Amer. Moll., p. 153, pl. 31, fig. 6 (holotype).

Description: "Shell small for genus, thin, delicate, elongated, fusiform; 5 varices per whorl; 6 major cords around body whorl, with 1 minor cord in-between; cords frilly, fimbriated; varices coarsely ribbed, cancellated; siphonal canal with 2 large, fimbriated cords; siphonal cords end in 2 large spines on each varix on siphonal canal; aperture large in proportion to shell size; shell color pale tan with varices being darker tan-brown; spire elevated; protoconch and early whorls brown." (Petuch, 1987)

Holotype: USNM 859805; height 11.2 mm, diameter 6.0 mm.

Type locality: 50 km south of Apalachicola, Florida, 150 meters.

Occurrence: Bermont Formation, Florida; Recent, Gulf of Mexico only (?).

Figured specimens: Fig. 4, USNM 859805 (holotype). Fig. 5, USNM 880027; height 16.2 mm, diameter 9.0 mm; locality, Sanibel, Florida. Fig. 6, USNM 482061; height 8.5 mm, diameter 5.4 mm; locality TU 978.

Discussion: In the material from the Steger Collection given to me some time ago there are three specimens said only to have "come from Sanibel." As they seem to be specimens of this apparently deep-water species, it is unfortunate that the locality data is not more specific.

Although described from the Recent fauna of the Gulf of Mexico, a single example (pl. 22, fig. 6) from the Bermont Formation at locality TU 978, South Bay, at the southern end of Lake Okeechobee, Florida, extends the range both geographically and temporally.

Favartia (Favartia) barbarae Vokes, n. sp.

Plate 23, figures 5, 6

Description: Shell with six teleoconch whorls; protoconch and earliest ornamentation unknown. Spiral ornamentation on second teleoconch whorl of one cord near anterior suture; on third teleoconch whorl a second cord added at shoulder, with faint secondary threads on shoulder ramp. Body whorl with five major cords; one additional major cord on siphonal canal. Several secondary threads on shoulder ramp, also between cord at base of body whorl and that on siphonal canal, and one between posterior two cords and anterior three cords on body whorl. With increasing shell size cords weakening in intervarical areas, best developed only immediately adjacent to ab- and adapertural faces of varices. Five to six varices on each whorl, not well-aligned up spire. At crossing of spiral cords, small open spines produced, that at shoulder largest. With increasing shell size, varices becoming larger and more elaborate; multiple shell layers on adapertural varical faces scalloped by spiral ornamentation. Shell surface be-

*When this specimen was photographed it was in the collection of Harvey Bullis, Jr., U.S. Fish and Wildlife Service, Bureau of Commercial Fisheries, at Pascagoula, Mississippi. Unfortunately, it was stored in a metal shed on the dock, adjacent to the Pascagoula River. The dock and the shed were washed away in a hurricane. As the specimen was never sent to the U.S. National Museum by Bullis, it is presumed to have been "lost at sea."

tween varices shagreened by intersection of faint spiral threads and small growth lamellae. Suture slightly appressed. Aperture ovate; inner lip smooth, free-standing in anterior portion, appressed in posterior portion. Inner side of outer lip faintly lirate, margin of outer lip crenulated by siphonal cords. Siphonal canal long for the genus, narrow, recurved dorsally. Shell color white, with two brown bands at shoulder and base of body whorl, best seen immediately adjacent to varices. In well-preserved specimens a faint frosting of intritacalx. Operculum unguiculate, nucleus terminal.

Holotype: USNM 880031; height 21.0 mm, diameter 11.9 mm.

Type locality: 180 km east of Arrecife Alacran, or approximately 75 km due north of Río Lagartos, Yucatan, on coral and broken shell. No depth was recorded but according to a bathymetric chart (*e.g.*, AAPG, 1984, Bathymetry of the Gulf of Mexico and the Caribbean Sea) the depth in this area is approximately 50 fathoms (= 91 meters).

Etymology of name: In honor of the late Barbara Steger (Mrs. Dan Steger), Tampa, Florida, who generously provided the type material, as well as much more over the years.

Occurrence: Known only from the type locality.

Figured specimens: Fig. 5, USNM 880031 (holotype). Fig. 6, USNM 880032 (paratype); height 19.8 mm, diameter 12.0 mm; locality same as holotype.

Discussion: Among material given to me several years ago by the late Barbara Steger, were three specimens dredged off the northern coast of Yucatan. The specimens have a similarity to *F. cellulosa* but are more attenuated and the intervarical space is smoother. The type locality is approximately 90 meters in depth, which is somewhat deeper than *F. cellulosa* lives.

The specimens were originally identified by Mrs. Steger as *Murexiella levicula* (Dall) and one can well understand why. Both species have about five almost winged varices; however, *M. levicula* is even smoother between the varices and does not have the "cellular" appearance of the spiral ornamentation typical of the genus *Favartia*. The varical extensions along the siphonal canal of *M. levicula* are ornamented by three small spines on each varix, but the canal of *F. barbarae* is almost smooth, and recurved dorsally, as is typical of *Favartia*. It is species such as *F. barbarae* that cause problems of separation between these two generic groups. Nevertheless, I believe the two are separable, as discussed above under the genus *Murexiella*.

(?)Favartia (Favartia) varimutabilis Houart
Plate 24, figures 5, 6

Favartia (Favartia) varimutabilis HOUART, 1991, Nautilus, v. 105, no. 1, p. 32, text-figs. 12 (protoconch), 20, 21 (radula) 34, 35 (holotype), 36 (paratype) [as *Favartia (Caribiella) varimutabilis*, p. 28, 29].

Favartia varimutabilis Houart. KAICHER, 1991, Card Catalogue World-wide Shells, pack 59, Muricidae – Part VI, no. 6007 (holotype).

Description: "Shell 8.5-9 mm in length, stout, fusiform. Spire high, with 2.5 protoconch whorls and 5 weakly convex, teleoconch whorls. Suture impressed. Protoconch whorls rounded, ending with a deeply indented varix. Last whorl with 3-5 irregular, rounded, erratically placed, squamose varices. Penultimate whorl bearing 8 or 9 varices. No intervarical axial sculpture. Spiral sculpture of 7 cords, occasionally with 1 thread between each pair of cords, 2 or 3 adapical cords sometimes extending as small spinelets or varices.

"Aperture roundly-ovate, outer lip erect and smooth, weakly lirate within. Columellar lip rim erect, with 2 or more small and narrow folds. Anal notch broad, shallow. Siphonal canal short, narrowly open, weakly bent adaperturally, ornamented with 2 small open spines. Shell pale orange to pale brown, with darker spiral cords." (Houart, 1991)

Holotype: MORG 26458; height 9 mm, diameter 5 mm (*fide* Houart, 1991).

Type locality: R/V *Marion-Dufresne* Station DC 15, approximately 150 km south of Vitória, Espírito Santo, Brazil, 37 meters.

Occurrence: Recent only, southeastern Brazil.

Figured specimen: Fig. 5, MORG 26458 (holotype). Fig. 6, MNHN (paratype); height 9.0 mm, diameter 5.1 mm; locality R/V *Marion-Dufresne* Station DC 22, Vitória Bank, approximately 200 km southeast of Vitoria, Espírito Santo, Brazil (photographs courtesy of R. Houart).

Discussion: The generic placement of this small species is questionable. Although Houart placed it in the genus *Favartia,* he described it as having "2 or more small folds" on the columellar lip, a characteristic not usually associated with that genus. Further, he expressed doubt as to whether the holotype (his figs. 34, 35) and the paratype (fig. 36) are conspecific. The paratype seems to be a species of *Favartia* similar to *F. zalaya* Vokes, with a

small, almost entire aperture. But the holotype of *F. varimutabilis* has a more open aperture with fairly strong lirae on the inner side of the outer lip, in addition to the columellar plicae, and the overall appearance is not like any known species of *Favartia*. However, neither is it like any other genus. Therefore, for the present, I am assuming that the holotype is aberrant, and the *Favartia*-like paratype is the more characteristic example.

Houart compares his new species to *Favartia (Caribiella) alveata* (Kiener) [in fact, his illustrations of the protoconch (fig. 12) and the radula (figs. 20, 21) are given as *Favartia (Caribiella) varimutabilis*] but there is little resemblance between the two forms.

Favartia (Favartia) species

Favartia (Favartia) sp. HOUART, 1991, Nautilus, v. 105, no. 1, p. 32, text-figs. 13 (protoconch), 33 (shell).

Occurrence: Recent only, Espírito Santo, Brazil.

Discussion: This small species (height 8.2 mm, diameter 5.0 mm) was figured by Houart from material dredged off southeastern Brazil (Vitória Bank, off Vitória, Espírito Santo, in 52 meters). As he noted, the specimens available were insufficient to compare with any known species of *Favartia*.

Subgenus CARIBIELLA Perrilliat, 1972

Caribiella PERRILLIAT, 1972, Paleontología Mexicana, no. 32, p. 82.

Type species: *Murex intermedius* C.B. Adams, 1850 (= *Murex alveatus* Kiener, 1842), by original designation.

Discussion: This small subgroup of *Favartia* is marked by having a more elongate, dorso-ventrally flattened shell. It is represented by only a few species: the type species in the western Atlantic; *F. erosa* (Broderip, 1833) and *F. purdyae* Vokes and D'Attilio, 1980, in the eastern Pacific; and *F. ponderi* Myers and D'Attilio, 1989, in the western Pacific. The American species are probably all descendants of the Late Miocene *F. carmenae*, n. sp. The Indo-Pacific species, *F. ponderi*, is so similar to the Caribbean *F. alveata* as to appear to be almost the same (see Vokes, 1985, pl. 3, figs. 25, 26) and its origin is a mystery.

Favartia (Caribiella) carmenae Vokes, n. sp.

Plate 24, figure 1

PLATE 24

Figures Page

1. *Favartia (Caribiella) carmenae Vokes*, n. sp 136
   (X 3) USNM 645986 (holotype); height 18.5 mm, diameter 9.5 mm.
   Locality: USGS 23737, Santa Rosa, Veracruz, Mexico. (?)Medias Aguas Formation.
2. *Favartia (Caribiella) erosa* (Broderip) 138
   (X 3) USNM 880033; height 16.5 mm, diameter 8.3 mm.
   Locality: Isla Gobernador, Panama. Recent.

3, 4. *Favartia (Caribiella) alveata* (Kiener) 139

3. (X 3) MCZ 156123 (lectotype – *M. intermedius* Adams); height 20.0 mm, diameter 10.0 mm.
   Locality: Jamaica. Recent.
4. (X 3) USNM 880034; height 18.9 mm, diameter 9.6 mm.
   Locality: Curaĉao, Netherlands Antilles. Recent.

5, 6. (?)*Favartia (Favartia) varimutabilis* Houart 135

5. (X 6) MORG 26458 (holotype); height 9.0 mm, diameter 5.0 mm.
   Locality: R/V *Marion-Dufresne* Station DC 15, off Vitória, Espiríto Santo, Brazil. Recent.
6. (X 6) MNHN (paratype); height 9.0 mm, diameter 5.1 mm.
   Locality: R/V *Marion-Dufresne* Station DC 22, off Vitória, Espiríto Santo, Brazil. Recent.

(Photographs courtesy of R. Houart)

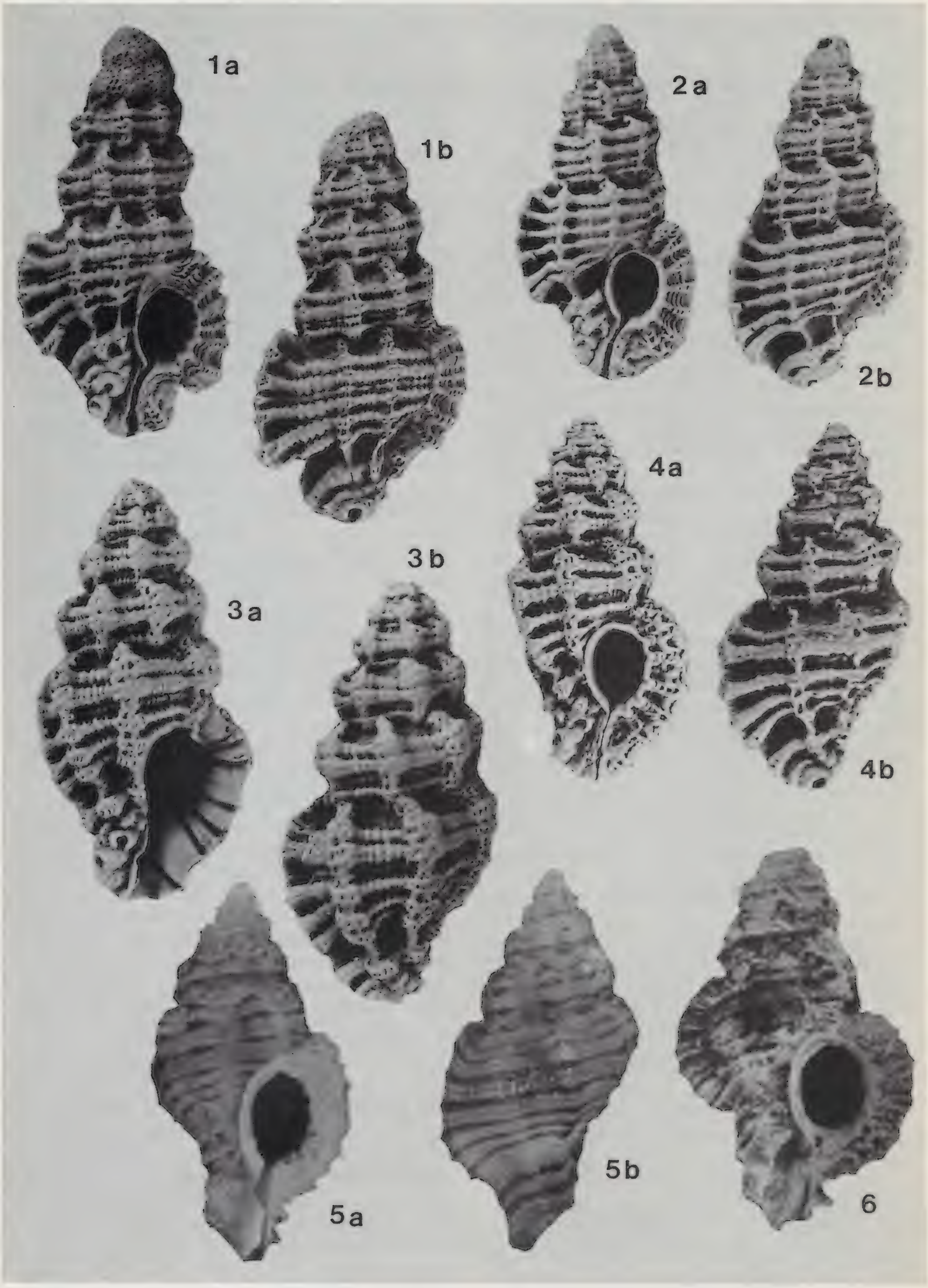

PLATE 24

Aspella (Caribiella) intermedius (C.B. Adams).
PERRILLIAT, 1972, Paleontología Mexicana, no. 32, p. 83, pl. 39, figs. 14, 15; pl. 40, figs. 1, 2 (*not* of Adams).

Description: Holotype (and only specimen) with six teleoconch whorls, protoconch and earliest ornamentation not known. Spiral ornamentation on early spire whorls of three flattened cords, that in middle the strongest; by fourth teleoconch whorl a smaller secondary cord intercalated between median and anterior cords. Body whorl with five heavy, convex-sided cords, formed of a series of overlapping scales resulting from incremental growth and giving the edges of the cords a saw-tooth pattern. Between posterior two cords and anterior three cords, a smaller intercalary cord, ornamented like the others but not as wide. An additional two heavy cords on siphonal canal; between cord at base of body whorl and those on siphonal canal a deeply excavated space lacking spiral ornamentation but crossed by axial ridges. Axial ornamentation on spire of about seven flattened varices per whorl, arching posteriorly to connect with previous whorls. At about fifth teleoconch whorl two varices on opposite sides of the whorl becoming larger, causing a dorso-ventral flattening, similar to species of the genus *Aspella*. Adapertural faces of the two enlarged varices elaborately filigreed by multiple layers of shell material scalloped by spiral cords; those former varices between the two enlarged ones decreasing in strength to little more than axial ridges. Shell surface between spiral cords shagreened with faint growth lamellae. Suture impressed, crossed by varices. Aperture ovate; inner lip smooth, anterior portion free-standing, posterior portion slightly appressed. Inner side of outer lip lirate within; margin crenulated by spiral cords. Siphonal canal short, broad, recurved distally; terminations of previous canals giving rise to a small fasciole.

Holotype: USNM 645986; height 18.5 mm, diameter 9.5 mm.

Type locality: USGS 23737, (?)Medias Aguas Formation; 3 km northeast of Santa Rosa [now Istal], formerly on the Veracruz to Santa Lucretia [now Jesus Carranza] railroad [which now exists only as the highway right-of-way to Istal], Veracruz, Mexico.

Etymology of name: In honor of Maria del Carmen Perrilliat Montoya, Instituto de Geología, Universidad Nacional Autonóma de México, for her outstanding contributions to the paleontology of Mexico.

Occurrence: (?)Medias Aguas Formation, Veracruz, Mexico.

Figured specimen: USNM 645986 (holotype).

Discussion: At the U.S. National Museum there is an extensive collection made in 1920 by Bruce Wade at a locality described as "the head of a small stream flowing into Arroyo Tomas Martinez, about 3 km to the northeast of Santa Rosa or about 28 km northwest of Santa Lucrecia [on the Ferrocarril de Veracruz al Pacifico, State of Veracruz]." In this collection, which has been monographed by Perrilliat (1972-1984) there is a single specimen of *Caribiella* assumed to be ancestral to both the western Atlantic and eastern Pacific Recent members of the subgenus.

We have tried to relocate this site for years, with no success, spending hours following trails over the hills in the general vicinity of "3 km northeast of Santa Rosa." I fear that in the years since 1920 the area has been so completely deforested and turned into cattle pasture that soil erosion has completely buried the former outcrop, which is certainly regrettable, for the Santa Rosa fauna is remarkable and unlike any other in the western Atlantic. It is similar to the famous Bowden, Jamaica, fauna in that it is a mixture of shallow and deep-water species, and almost certainly represents a gravity-flow of shallow-water material into deeper water.

At Santa Rosa itself (locality TU 1323) and nearby (TU 1324), Dr. W.H. Akers (personal communication, 1979) has dated the beds as Neogene Zone N. 17, or Late Miocene, and the name Medias Aguas Formation has been proposed for these beds by Akers (1980, p. 487). I assume that the Santa Rosa fauna is the same but there is nothing in the muricid species that confirms or denies this dating.

The new species was referred by Perrilliat (1972, p. 83) to the Recent *F. alveata* (under the name *Aspella intermedius*). But it differs from the living species in having a more pronounced bilateral flattening, mimicking the genus *Aspella* to which it is only distantly related. In general shape this Mexican species more closely resembles the Recent eastern Pacific *F. erosa* (Broderip, 1833) (pl. 24, fig. 2) but differs in not having the flattened spiral cords, as in both *F. erosa* and *F. purdyae*. A detailed comparison, with excellent drawings, of the spiral ornamentation on *F. alveata* and *F. erosa* has been given by D'Attilio (1988, p. 74), who described the spiral ornamentation seen in both *F. carmenae* and *F. alveata* as: "The scabrous segments of each cord are fluted, raised strongly in relief,

bowl-like with scalloped edges, each bowl-form segment narrower at its contact with the one below." Like the Atlantic *F. alveata,* the Mexican species is marked by having small spiral threads between the major spiral cords, a feature not seen in the Pacific species.

FAVARTIA (CARIBIELLA) ALVEATA
(Kiener)
Plate 24, figures 3, 4

Murex erosus var. G.B. SOWERBY, II, 1841, Conch. Illus., *Murex,* fig. 96.

Murex alveatus KIENER, 1842, Coq. Viv., v. 7, *Murex,* p. 94, pl. 46, fig. 2; REEVE, 1845, Conch. Icon., v. 3, *Murex,* pl. 32, figs. 157, 163; SOWERBY, 1879, Thes. Conch., v. 4, *Murex,* pl. 23, fig. 232.

Murex intermedius C.B. ADAMS, 1850, Cont. to Conch., v. 1, no. 4, p. 60 (*non M. intermedius* Brocchi, 1814).

Ocinebra alveata (Kiener). TROSCHEL, 1869, Das Gebiss der Schnecken, v. 2, p. 119, pl. 11, fig. 10 (radula).

Murex (Favartia) intermedius Adams. DALL and SIMPSON, 1901, U.S. Fish Comm., Bull., v. 20, pt. 1, p. 408.

Tritonalia intermedia (Adams). M. SMITH, 1939, Illus. Cat. Recent Species Rock Shells, p. 16, pl. 12, fig. 12 (SMITH, 1953, *ibid.*); CLENCH and TURNER, 1950, Occ. Papers Moll., Harvard Univ., v. 1, no. 15, p. 294, pl. 39, fig. 15 (lectotype).

Ocenebra intermedia (Adams). WARMKE and ABBOTT, 1961, Caribbean Seashells, p. 108, fig. 19i; HUMFREY, 1975, Sea Shells of the West Indies, p. 142, pl. 16, fig. 12.

Aspella elegans "Perrilliat Montoya." VOKES, 1971, Bulls. Amer. Paleontology, v. 61, no. 268, p. 44 (said to be "n.n. pro *intermedius* Adams" in Perrilliat, 1971 [1972], but not actually published by her].

Caribiella intermedius (C.B. Adams). VOKES, 1971, Bulls. Amer. Paleontology, v. 71, no. 268, p. 60.

Favartia (Caribiella) alveata (Kiener). ABBOTT, 1974, Amer. Seashells (ed. 2), p. 187, fig. 1955; VOKES and VOKES, 1983, Mesoamer. Ecol. Inst., Mon. 1 (MARI Publ. 54), p. 24, pl. 12, fig. 12; VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 214, pl. 2, fig. 14; VOKES, 1985, Conch. Amer., Bull., v. 13, no. 2, p. 33, pl. 3, fig. 25; D'ATTILIO, 1988, Festivus, v. 20, no. 8, p. 73, text-figs. 1, 2 (shell), 5, 6 (detail of sculpture).

Caribiella alveata (Kiener). KAICHER, 1974, Card Catalogue World-wide Shells, pack 6, Muricidae – Part II, no. 582.

Favartia alveata (Kiener). RIOS, 1975, Brazilian Marine Moll. Icon., p. 86, pl. 25, fig. 354; RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 144, pl. 24, fig. 16, text-fig. 92 (detail of sculpture, mislabeled as *F. erosa*); FAIR, 1976, The Murex Book, p. 20, pl. 20, figs. 302, 302A; RIOS, 1985, Seashells of Brazil, p. 85, pl. 30, fig. 371; DE JONG and COOMANS, 1988, Stud. Fauna Curaçao, Caribbean Islands, v. 49, p. 73.

Description: "M. testa oblonga, costis varicibusque reticulata, alba, spira longissima; varicibus sex aut octo, regulariter ordinatis, seriatim alveatis; apertura parva, rotunda; labro dextro crasso, intus denticulato; canali brevissimo." (Kiener, 1842)

Holotype: Not found (not at Muséum National d'Histoire Naturelle, Virginie Heros, letter, 1993); height 22 mm (*fide* Kiener, 1842, p. 94).

Type locality: Jamaica (type locality of *Murex intermedius* Adams).

Occurrence: Recent only, from Bermuda to Bahia, Brazil, off the coast of Louisiana and Texas to Costa Rica and northern South America.

Figured specimens: Fig. 3, MCZ 156123 (lectotype – *M. intermedius* Adams); height 20.0 mm, diameter 10.0 mm; locality, Jamaica. Fig. 4, USNM 880034, height 18.9 mm, diameter 9.6 mm; locality, Curaçao, Netherlands Antilles.

Discussion: The original illustration of *Murex alveatus* is rather small, being presented at life-size, and there is no type locality, but the original description is good, and Kiener compares his species with other species of the genus *Favartia.* It is surprising that the similarity between the Kiener species and that of C.B. Adams was not recognized earlier.

While I was preparing the Catalogue of the genus *Murex* (Vokes, 1971a), Carmen Perrilliat, Instituto de Geología, UNAM, Mexico, was working on her monograph of the Santa Rosa fauna, discussed above. We had much correspondence regarding the identity of the small species named above as *F. carmenae.* I felt that it was a new species near *Murex intermedius* and *"Aspella" erosa* (as we thought of it in those days!) but that it should be reassigned subgenerically.

In February, 1970, she advised me that she had borrowed the type material of *Murex intermedius* from the Harvard Museum of Comparative Zoology and she was of the opinion that the Santa Rosa specimen and the Jamaican one were the same species, which she proposed to rename *"Aspella (Caribiella) elegans,* n.n., as *Murex intermedius* is preoccupied."

In February, 1971, her publication was still "in press" but she advised me that she had seen page proof and gave me the reference to "Paleontología Mexicana, Num. 32, 1971, p. 83, lam. 39, figs. 14, 15; lam. 40, figs. 1, 2." At this time I was holding up the page proof on my own Catalogue, so with the information she sent I went ahead and included the name *Aspella elegans* Perrilliat, 1971, *n.n. pro M. intermedius*, type of *Caribiella*.

My paper appeared in August, 1971, and it was not until 1972 that Perrilliat's work finally appeared. Imagine my surprise (and chagrin) to open it and discover that instead of *Aspella elegans*, she had reverted to *Murex intermedius* for the type of *Caribiella*, and the Santa Rosa species. Thus, we have a nomenclatorial tangle. The taxon *Aspella elegans* is valid as Perrilliat *in* Vokes, 1971, *n.n. pro Murex intermedius* Adams *non* Brocchi [ICZN Code Art. 13(a)iii] and becomes another subjective synonym of *Murex alveatus* Kiener. However, the generic taxon *Caribiella* is not valid "*in* Vokes" as there was no description [ICZN Art. 13(b)].*

Subgenus PYGMAEPTERYS Vokes, 1978

Pygmaepterys VOKES, 1978, Ann. Natal Mus., v. 23, no. 2, p. 398.

Type species: *Murex alfredensis* Bartsch, 1915, by original designation.

Discussion: This is another of the groups for which the western Atlantic species have been monographed (Vokes and D'Attilio, 1980). At that time, the generic placement of the subgenus was in question. Originally, *Pygmaepterys* was proposed as a subgenus of the muricine genus *Pterynotus* Swainson, 1833 (type species: *Murex pinnatus* Swainson, 1833). But, the radula of one of the Caribbean species assigned to *Pygmaepterys* is muricopsine. The question in 1980 was whether the Caribbean *P. germainae* and the East African type species were, in fact, both referable to the same subgenus, or was this parallelism, so typical of the family Muricidae as a whole.

Regrettably, we still do not have the answer. No one has yet examined the animal of the type species. Other Indo-Pacific species, such as *F.(P.) yemenensis* (Houart and Wranik, 1989), have a muricopsine radula (Houart and Wranik, 1989, text-fig. 2), similar to that of the Eastern Pacific *F.(P.) poormani* Radwin and D'Attilio (1976, text-fig. 181). However, their radulae differ slightly from the western Atlantic *F.(P.) germainae* (Vokes and D'Attilio, 1980, text-fig. 1) in having several secondary denticles toward the outer edges of the rachidian tooth (rather like the radula of some species of *Murexsul* and, especially, *Maxwellia* – see Radwin and D'Attilio, 1976, *Maxwellia gemma*, text-fig. 97).

Therefore, I am placing all of these species with similar morphology in the subgenus *Pygmaepterys*, with the understanding that in time, we may change this assignment. The general morphology of this group consists of relatively small shells (most 10 mm or less in height, although a few "giant" species measure up to 20 mm), with numerous (three to ten) winged varices on the body whorl, strong spiral sculpture, and a denticulate aperture. Denticles may or may not be present on the inner lip, but are always present on the inner side of the outer lip.

Once the subgenus was delineated, several previously described species were recognized as members of *Pygmaepterys*. In addition, several new species have been described since 1978, so that today at least 23 species, fossil and Recent, are considered members of this subgenus.

The subgenus is world-wide tropical in distribution, with 11 Recent species in the Indo-Pacific and seven living species in the western Atlantic. Two more are known from the Chipola Formation and one Recent form is known from the eastern Pacific. In Europe there is one fossil species in the Stampian (Oligocene) of France: *"Murex" subdecussatus* d'Orbigny, 1852 (*n.n. pro Murex decussatus* Grateloup, 1846, *non Gmelin*, 1791); and a second in the Miocene of Romania: *"Murex" giselae* Boettger, 1901. The latter was previously assigned to *Pazinotus* (Vokes, 1970, p. 6), but examination of the illustration of the type in Zilch (1934, pl. 15, fig. 79) and another specimen in the Mayer Eymar Col-

*Thankfully, for we are thus spared the necessity of having to cite the subgenus as *Caribiella* Perrilliat *in* Vokes, type species: *Aspella elegans* Perrilliat *in* Vokes, *n.n. pro M. intermedius* Adams *non* Brocchi (= *Murex alveatus* Kiener)!

lection (now part of the Naturhistorisches Museum Basel collections) shows that the shell surface is ornamented by the characteristic *Pygmaepterys* growth lamellae and is unlike the smooth *Pazinotus*. There may be other fossil species that have not been recognized. Without a specimen in hand one would not suspect that *"Murex" subdecussatus* should be placed here, but examination of a specimen (see pl. 25, fig. 3) immediately demonstrates the similarity to the Chipola species *F.(P.) pratulum* (pl. 25, fig. 2).

FAVARTIA (PYGMAEPTERYS) DREZI
(Vokes and D'Attilio)
Plate 25, figure 1

?*Pygmaepterys drezi* VOKES and D'ATTILIO, 1980, Tulane Stud. Geol. Paleont., v. 16, no. 2, p. 48, pl. 1, fig. 5.

Description: "Shell large for the group; with five post-nuclear whorls; protoconch unknown. Spiral ornamentation consisting of two major cords on the first and succeeding post-nuclear whorls; with on the body whorl five strong cords and, in addition, one or more intercalary minor cords. On the short siphonal canal another two major cords and some minor cords. Axial ornamentation of narrow recurved varices, eight in number on each whorl before the adult body whorl; there every other varix tending to be obsolete – only six varices on the body whorl of the holotype with intervarical nodes replacing the "lost" varices. Adapical edge of each varix flexed toward the aperture, reflecting the posterior expansion of the columellar lip. Spiral cords crossing the varices forming short spinelets, largest at the shoulder. Adapertural faces of the varices covered by numerous minutely crenulate lamellae; in addition, intervarical areas crowded with crenulate axial growth lamellae. Aperture oval, inner side of outer lip with six denticles, corresponding to the areas between the spiral cords. Inner lip smooth, appressed, with a wide expansion at the posterior end and three small denticles at the anterior end. Siphonal canal short, broad, slightly recurved at the distal end; former terminations making a small fasciole." (Vokes and D'Attilio, 1980)

Holotype: USNM 294289; height 11.8 mm, diameter 7.0 mm.

Type locality: TU 546, Chipola Formation; Tenmile Creek, about 1 3/4 miles west of Chipola River (NE 1/4 Sec. 12, T1N, R10W), Calhoun County, Florida.

Occurrence: Chipola Formation, Florida.

Figured specimen: USNM 294289 (holotype). Additional locality: TU 830.

Discussion: The inflated whorl shape and denticulate inner lip indicates that this species probably is ancestral to the Late Miocene to Recent *F.(P.) germainae*. In the type lot there are three specimens, but no additional material has been discovered since 1980 and nothing can be added to the previous discussion.

FAVARTIA (PYGMAEPTERYS) PRATULUM
(Vokes and D'Attilio)
Plate 25, figure 2

Pygmaepterys pratulum VOKES and D'ATTILIO, 1980, Tulane Stud. Geol. Paleont., v. 16, no. 2, p. 49, pl. 1, figs. 6, 7; GIBSON SMITH and GIBSON SMITH, 1983, Veliger, v. 25, no. 3, p. 180.

Description: "Shell large for the group, with six post-nuclear whorls and a protoconch of two and one-half somewhat bulbous whorls. Spiral ornamentation beginning with first one, then two strong cords, and a faint third at the shoulder, increasing to seven on the body portion of the last whorl and several smaller cords on the siphonal canal. Axial ornamentation of nine lamellar varices on each whorl except the last where there are only six to eight, with no trace of 'remnant' varices in the form of intervarical nodes where the varices would have been. Varices composed of a series of laminae pressed together; both the ad- and abapertural faces markedly scabrous. Spiral cords crossing the varices as small channels of outfolded laminae, giving the illusion of spinelets, especially at the shoulder. Varices standing free along the siphonal canal as a laminated frill, in the manner of *Naquetia;* with numerous axial growth lamellae between the varices, elaborately crenulated by invisible spiral threads, giving the intervarical areas a cancellate appearance. Aperture elongate-oval; inner lip smooth, only slightly expanded and appressed at the posterior end; inner side of outer lip with seven denticles, those in the center tending to be paired. Siphonal canal medium in length, only indistinctly set off from body whorl. Distal end slightly recurved, with the tips of former canals forming a long curved fasciole." (Vokes and D'Attilio, 1980)

Holotype: USNM 294290; height 10.9 mm, diameter 5.5 mm.

Type locality: TU 546, Chipola Formation; Tenmile Creek, about 1 3/4 miles west of Chipola River (NE 1/4 Sec. 12, T1N, R10W), Calhoun County, Florida.

Occurrence: Chipola Formation, Florida.

Figured specimen: USNM 482062; height 12.3 mm, diameter 6.3 mm; locality TU 830. Additional localities: TU 554, 950, 951.

Discussion: Since the original description, only a single example of this species has been collected (by Gary W. Schmelz at locality TU 830). This specimen (pl. 25, fig. 2) is slightly larger than the holotype and clearly shows the decrease in the number of varices on the body whorl.

FAVARTIA (PYGMAEPTERYS) GERMAINAE (Vokes and D'Attilio) Plate 25, figure 4

?*Pygmaepterys germainae* VOKES and D'ATTILIO, 1980, Tulane Stud. Geol. Paleont., v. 16, no. 2, p. 50, pl. 1, figs. 1-4, text-fig. 1 (radula); GIBSON SMITH and GIBSON SMITH, 1983, Veliger, v. 25, no. 3, p. 179.

Pygmaepterys germaineae [sic] Vokes and D'Attilio . KAICHER, 1980, Card Catalogue World-wide Shells, pack 25, Muricidae – Part V, no. 2580 (holotype).

Favartia (Pygmaepterys) germainae (Vokes and D'Attilio). VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 214.

Favartia (?Pygmaepterys) germainae (Vokes and D'Attilio). VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 72, pl. 8, fig. 6.

Pygmaepterys germainae Vokes and D'Attilio. HOUART, 1991, Nautilus, v. 105, no. 1, p. 32, text-fig. 37.

Description: "Shell small, with four post-nuclear whorls and a protoconch of approximately one and one-half bulbous whorls, the exact termination being difficult to ascertain among the overlapping varices from the first post-nuclear whorl well onto the protoconch. Spiral ornamentation of two strong cords on the spire; five major spiral cords on body whorl; three somewhat weaker cords on the siphonal canal. Axial ornamentation of seven varices on each whorl except the last, where there is a tendency to drop one of the varices, leaving a small intervarical node in place of the varix. Intervarical areas covered with elaborate crenulated axial growth lamellae, between and crossing the spiral cords. Each varix forming as a flange, well behind the aperture, with the adapertural face also ornamented by growth lamellae, with small recurved spinelets where the spiral cords cross the varices, that at the shoulder being the longest; a strong adapertural flexure at the adapical end of each varix, reflecting the posterior expansion of the inner lip. Aperture oval, inner lip in adult specimens with about four denticles at the anterior end and another two at the expanded and appressed posterior end. Outer lip with six strong denticles, corresponding to the area between the spiral cords. Siphonal canal short, broad, recurved at the distal end, terminations of former canals forming a small fasciole. Shell color a light beige, aperture a rich mahogany. Operculum straw-colored, typically muricoid, with a terminal nucleus. Radula muricopsine." (Vokes and D'Attilio, 1980)

Holotype: USNM 783319; height 7.3 mm, diameter 4.0 mm.

Type locality: Off Punta Higüero (or Jigüero), northwestern Puerto Rico, 90 meters.

Occurrence: Cercado and Gurabo formations,

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Figures — Page

1. *Favartia (Pygmaepterys) drezi* (Vokes and D'Attilio) 141
   (X 4) USNM 294289 (holotype); height 11.8 mm, diameter 7.0 mm.
   Locality: TU 546, Tenmile Creek, Florida. Chipola Formation.
2. *Favartia (Pygmaepterys) pratulum* (Vokes and D'Attilio) 141
   (X 4) USNM 482062; height 12.3 mm, diameter 6.3 mm.
   Locality: TU 830, Tenmile Creek, Florida. Chipola Formation.
3. *Favartia (Pygmaepterys) subdecussata* (d'Orbigny) 141
   (X 4) NMB H 17472; height 11.5 mm, diameter 5.5 mm.
   Locality: Dax, France. Stampian.
4. *Favartia (Pygmaepterys) germainae* (Vokes and D'Attilio) 142
   (X 6) USNM 783320 (paratype A); height 7.0 mm, diameter 4.0 mm.
   Locality: Colón, Panama. Recent.
5. *Favartia (Pygmaepterys) richardbinghami* (Petuch) 147
   (X 4) USNM 859847 (holotype); height 16.1 mm, diameter 7.8 mm.
   Locality: off Palm Beach Island, Florida. Recent.
6, 7. *Favartia (Pygmaepterys) oxossi* (Petuch) 144
   6. (X 6) USNM 780650 (holotype); height 9.0 mm, diameter 4.6 mm.
      Locality: Abrolhos Archipelago, Brazil. Recent.
   7. (X 5) USNM 880035; height 10.0 mm, diameter 5.8 mm.
      Locality: off Guarapari, Espírito Santo, Brazil. Recent.

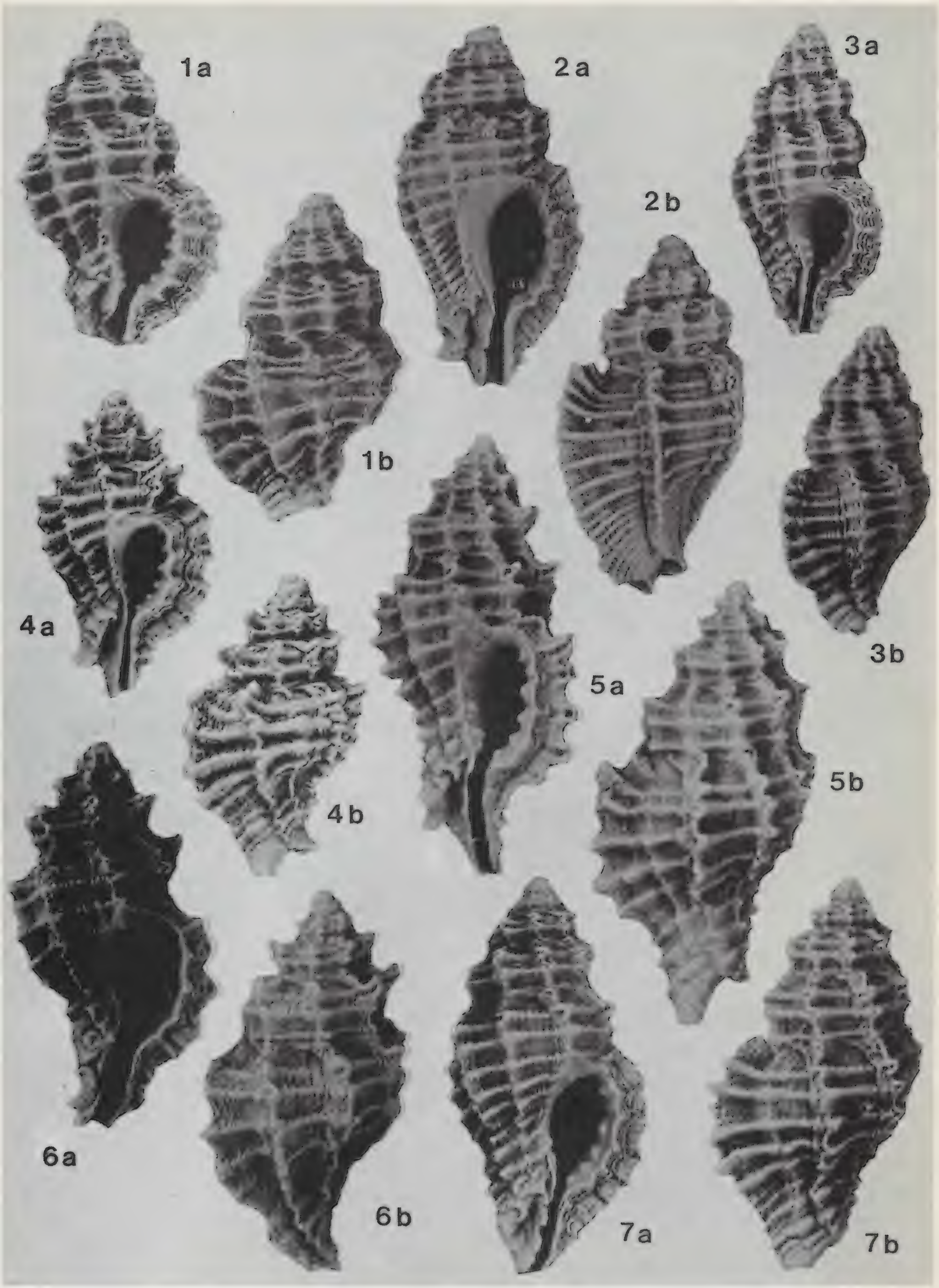

PLATE 25

Dominican Republic; Moín Formation, Costa Rica; Recent, from Puerto Rico to Panama and Espírito Santo, Brazil.

Figured specimen: USNM 783320 (paratype A); height 7.0 mm, diameter 4.0 mm; locality, Colón, Panama. Additional localities: TU 953, 1215, 1227A, 1230, 1250.

Discussion: This small species (maximum height 8 mm) occurs in the Recent fauna of the Caribbean at depths of 12 to 90 meters. We have some 25 specimens from the Cercado and Gurabo formations of the Dominican Republic. Its rarity in the reported Recent faunas probably is due to its small size. When described it was known from as far south as Panama, but since then Houart (1991, p. 32) has extended the range to the submarine banks off Espírito Santo, Brazil.

FAVARTIA (PYGMAEPTERYS) OXOSSI (Petuch)
Plate 25, figures 6, 7

Muricopsis oxossi PETUCH, 1979, Biol. Soc. Washington, Proc., v. 92, no. 3, p. 517, figs. 1-G, 1-H; VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 214; RIOS, 1985, Seashells of Brazil, p. 84, pl. 30, fig. 370 (holotype); PETUCH, 1987, New Caribbean Moll. Faunas, p. 26, 140, pl. 15, figs. 15, 16 (holotype); PETUCH, 1988, Neogene Hist. Trop. Amer. Moll., p. 163, pl. 39, figs. 8, 9 (holotype).

Description: "Small, fusiform, spire high, acute; suture indistinct; sculpture consisting of 5 raised axial cords and numerous close-packed, overlapping scales, giving shell lamellose appearance; varices flattened, winglike, heavily scaled, with 5 flattened spines along edges; spine on shoulder largest, recurved posteriorly; spines on last varices fused into single large varical wing with serrate edge; 7 varies [*sic*] on last whorl of holotype; color creamy-yellow with 3 slightly darker bands, one at shoulder, one at mid-body, and one at base of siphonal canal; shell covered with irregular white intriticalx [*sic*]; siphonal canal long, fully 1/4 of shell length; aperture white; inner edge of outer lip with 5 low, rounded teeth; operculum unknown." (Petuch, 1979)

Holotype: USNM 780650; height 9.0 mm, diameter 4.6 mm.

Type locality: 2 km east of Santa Barbara Island, Abrolhos Archipelago, Bahia, Brazil, 25 meters.

Occurrence: Recent only, known only from Brazil.

Figured specimens: Fig. 6, USNM 780650 (holotype). Fig. 7, USNM 880035; height 10.0 mm, diameter 5.8 mm; locality, Rasa Island, off Guarapari, Espírito Santo, Brazil, 30 meters.

Discussion: The holotype of *Muricopsis oxossi* Petuch (1979, p. 517, figs. 1-G, 1-H) is immature and does not show the expanded terminal varix. As the subgenus *Pygmaepterys* had not been recognized in the western Atlantic at the time of the description, the similarities were overlooked. However, the surface of the holotype is covered with growth lamellae, as is typical of

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Figures Page

1-3. *Favartia (Pygmaepterys) juanitae* (Gibson Smith and Gibson Smith) 146
1. (X 8) USNM 784694 (holotype); height 7.6 mm, diameter 3.7 mm.
Locality: Borburata, Carabobo State, Venezuela. Recent.
(Photographs courtesy of J. Gibson Smith)
2. (X 8) USNM 880036; height 6.7 mm, diameter 3.5 mm.
Locality: same as holotype.
3. (X 6) Shasky Collection; height 9.2 mm, diameter 4.7 mm.
Locality: Isla Margarita, Venezuela. Recent.

4, 5. *Favartia (Pygmaepterys) aliceae* (Petuch) 147
4. (X 5) USNM 859846 (holotype); height 11.0 mm, diameter 5.7 mm.
Locality: Bonaire, Netherlands Antilles. Recent.
5. (X 6) Sunderland Collection; height 9.1 mm, diameter 4.9 mm.
Locality: Bonaire, Netherlands Antilles. Recent.

6. *Favartia (Pygmaepterys) lourdesae* (Gibson Smith and Gibson Smith) 146
(X 8) USNM 784695 (holotype); height 6.0 mm, diameter 3.3 mm.
Locality: Isla La Orchila, Venezuela. Recent.
(Photographs courtesy of J. Gibson Smith)

7. *Favartia (Pygmaepterys) rauli* (Espinosa) 147
(X 6) USNM 880037 (paratype); height 7.5 mm, diameter 4.7 mm.
Locality: Cienfuegos, Cuba. Recent.

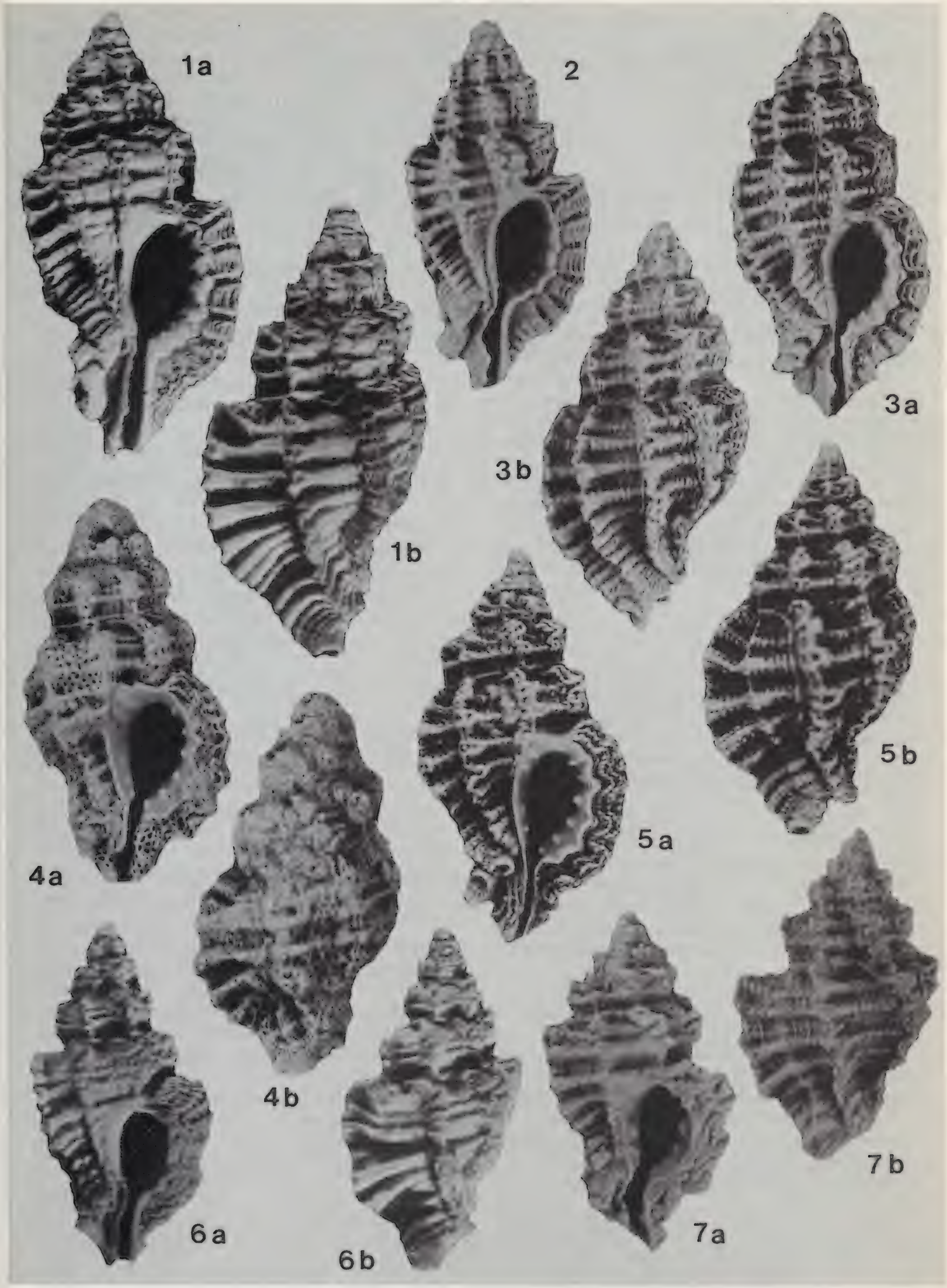

PLATE 26

the group. A second specimen of *F.(P.) oxossi* (pl. 25, fig. 7), collected by the Coltro brothers on the coast of Brazil, shows better the true nature of the adult shell.

FAVARTIA (PYGMAEPTERYS) JUANITAE
(Gibson Smith and Gibson Smith)
Plate 26, figures 1-3

Pygmaepterys juanitae GIBSON SMITH and GIBSON SMITH, 1983, Veliger, v. 25, no. 3, p. 179, text-figs. 6, 7.

Favartia (Pygmaepterys) juanitae (Gibson Smith and Gibson Smith). VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 214, pl. 2, fig. 16.

Description: "Shell small with five and three-quarter whorls. Protoconch of one and one-quarter white, translucent, bulbous whorls; surface microscopically granular; terminating with a low, rounded, opisthocyrt varix, followed almost immediately by the first varix of the teleoconch, with nine, hook-like varices in all on the first turn, adhering to and projecting above the protoconch, thus hiding it. First sculpture of two spiral cords crenulating the simple varices. On the second turn a third spiral cord appears, the varices become compounded by axial growth lamellae which cover, also, the areas between varices. A fourth cord lies in the suture with a wider interspace between it and the earlier cords. Below, on the bodywhorl, are three more spiral cords decreasing in strength down to the base of the whorl, followed by five minor cords on the canal. The terminations of the varices accentuate the anterior fasciole. The nine varices, aligned along the spire, continue to the last whorl where one is missing, usually the penultimate. The top of each varix runs forward to meet the previous whorl at the subsequent varix. The spiral cords terminate on each varix in a minuscule open spine, except for the uppermost cord at the shoulder where there is a strong spine curved abaperturally. Aperture oval, the outer lip projecting well forward of the terminal varix. Inner lip smooth, outer lip with seven denticles corresponding to the interspaces between the major spiral cords. Anterior canal almost as long as the aperture, partially closed and slightly recurved. Shell cream-coloured with a narrow brown band just below the suture and another just above at mid-whorl, occupying the wider spiral interspace; the top of the aperture and the middle of the outer lip stained brown, accordingly." (Gibson Smith and Gibson Smith, 1983)

Holotype: USNM 784694; height 7.6 mm, diameter 3.7 mm.

Type locality: Borburata, Carabobo State, Venezuela.

Occurrence: Recent only, northern Venezuela.

Figured specimens: Fig. 1, USNM 784694 (holotype; photographs courtesy of J. Gibson Smith). Fig. 2, USNM 880036; height 6.7 mm, diameter 3.5 mm; locality same as holotype. Fig. 3, Shaskey Collection; height 9.2 mm, diameter 4.7 mm; locality, Islas Los Frailes, off Isla Margarita, Venezuela, 7 meters on coral.

Discussion: As noted by the original authors this Venezuelan species is most closely related to the Late Early Miocene Chipola species *F.(P.) pratulum*. In the Recent species the spiral cords are somewhat more flattened and the varices lack the adapically directed spines at the shoulder but otherwise the forms are markedly similar.

Material collected by Donald Shaskey, Redlands, California, contains several specimens from the northeastern corner of Isla Margarita, Venezuela, which seem most nearly referable to *P. juanitae*. The Isla Margarita specimens (pl. 26, fig. 3) are somewhat more rounded in outline, lacking the angulate shoulder of *P. juanitae* but having the eight flattened spiral cords that distinguish this species from similar forms. They may prove to be yet another species but for now they are included in *P. juanitae*, thus extending the range to the offshore islands of Venezuela.

FAVARTIA (PYGMAEPTERYS) LOURDESAE
(Gibson Smith and Gibson Smith)
Plate 26, figure 6

Pygmaepterys lourdesae GIBSON SMITH and GIBSON SMITH, 1983, Veliger, v. 25, no. 3, p. 180, text-figs. 8, 9.

Favartia (Pygmaepterys) lourdesae (Gibson Smith and Gibson Smith). VOKES, 1984, Shells and Sea Life, v. 16, no. 11, p. 214.

Description: "Shell small, pure white. The protoconch and spiral sculpture as in *Pygmaepterys juanitae*. On the bodywhorl there are five primary spiral cords; the three of the spire whorls, followed below by the wider interspace, then by two more primary cords to the base of the shell; along the canal are two to five (usually four) minor cords. On the last whorl the varices reduce from nine to eight, sometimes seven. The outer edge of the scabrous varices is indented at the junction between outer lip and anterior canal. Inner lip smooth, denticles in outer lip rudimentary, numbering about five." (Gibson Smith and Gibson Smith, 1983)

Holotype: USNM 784695; height 6.0 mm, diameter 3.3 mm.

Type locality: Isla La Orchila, Venezuela.

Occurrence: Recent only, offshore islands along the north coast of Venezuela.

Figured specimen: USNM 784695 (holotype; photographs courtesy of J. Gibson Smith).

Discussion: This second Venezuelan species of *Pygmaepterys* was described from the off-shore islands (Isla La Orchila, Islas Roques, Isla Tortuga) and is smaller than *F.(P.) juanitae*. It does not have a close relationship to any of the known species of the subgenus.

FAVARTIA (PYGMAEPTERYS) RICHARDBINGHAMI (Petuch)

Plate 25, figure 5

Muricopsis richardbinghami PETUCH, 1987, New Caribbean Moll. Faunas, p. 26, pl. 5, figs. 12, 13.

Pygmaepterys richardbinghami (Petuch). KAICHER, 1990, Card Catalogue World-wide Shells, pack 59, Muricidae – Part VI, no. 6098 (holotype).

Description: "Shell fusiform, elongated, with elevated spire; shell with 8 varices per whorl; body whorl ornamented with 5 large, evenly-spaced, raised cords; siphonal canal with 4 cords; spire whorls with 3 spiral cords; shoulder tabulate, sharp-angled; varices thin, winglike, with 5 large, bladelike serrations; serrations correspond to cords in intervarical regions; posteriormost serration largest, spinelike, pointed posteriorly; aperture small, oval; outer lip thickened, with 5 large denticles along inner edge; shell color tan, with 2 thin reddish-brown bands, 1 around subsutural region and 1 around break between body whorl and siphonal canal; spire whorls with reddish-brown subsutural band; interior of aperture pale tan." (Petuch, 1987)

Holotype: USNM 859847; height 16.1 mm, diameter 7.8 mm.

Type locality: Off Palm Beach Island, Palm Beach County, Florida, under coral rubble, 100 ft. [30 meters].

Occurrence: Recent only, known only from the type locality.

Figured specimen: USNM 859847 (holotype).

Discussion: Also named in the genus *Muricopsis* and compared by the author to *Muricopsis oxossi*, the fimbriate nature of the surface ornamentation indicates placement in *Pygmaepterys* the best choice for this species, as it is for *F.(P.) oxossi*. Known only from the holotype, this is is the largest species of *Pygmaepterys* in the western Atlantic. Additional material may demonstrate synonymy with *F.(P.) oxossi*.

FAVARTIA (PYGMAEPTERYS) ALICEAE (Petuch)

Plate 26, figures 4, 5

Muricopsis aliceae PETUCH, 1987, New Caribbean Moll. Faunas, p. 100, pl. 17, figs. 8, 9.

(?)*Pygmaepterys aliciae [sic]* (Petuch). KAICHER, 1991, Card Catalogue World-wide Shells, pack 59, Muricidae – Part VI, no. 6007 (holotype).

Description: "Shell small for genus, elongated, with high, elevated spire; 6 fimbriated varices per whorl; varices with 6 short, bladelike serrations; intervarical areas and backs of varices of body whorl with 6 large, raised, fimbriated spiral cords; inside of lip with 6 large denticles; shell color pure white." (Petuch, 1987)

Holotype: USNM 859846; height 11.0 mm, diameter 5.7 mm.

Type locality: Southern coast of Bonaire, Netherlands Antilles, in coral rubble, 2 meters.

Occurrence: Recent only, Netherlands Antilles.

Figured specimens: Fig. 4, USNM 859846 (holotype). Fig. 5, Sunderland Collection; height 9.1 mm, diameter 4.9 mm; locality, Bonaire, Netherlands Antilles, 2-3 meters.

Discussion: In his description Petuch does not mention two small denticles on the columellar lip of this species. Although four species of *Pygmaepterys* occur in the southern Caribbean, *F.(P.) aliceae* may be distinguished readily by the rounded nature of the shell outline and its slightly larger size. Unlike the other three, this species has a rounded outline with the maximum diameter at the mid-point of the body whorl, not at the shoulder, as in the others. The species it most nearly resembles is the Chipola Formation *F.(P.) drezi*, in which the whorls are more inflated, causing the suture to be more impressed.

FAVARTIA (PYGMAEPTERYS) RAULI (Espinosa)

Plate 26, figure 7

Pygmaepteris [sic] rauli ESPINOSA, 1990, Poeyana, no. 407, p. 1, text-fig. 1a, 1b (holotype), 1c (paratype), 1d (juvenile).

Description: "Concha subfusiforme ancha, de tamanõ pequeño. La protoconcha está formada por una vuelta algo grande y redondeada, de superficie aparentemente lisa; pero con puntos microscópicos, la cual pasa a la teleoconcha sin escultura de transición. La teleoconcha tiene unas cinco vueltas, con seis várices axiales por vuelta, estrechas y laminares en su parte anterior. La várice labral es la más desarrollada. En la

última vuelta la escultura espiral está formada por cuatro cordones primarios: los dos superiores más unidos entre sí; de tres a cuatro cordones basales menos marcados por debajo de los cordones primarios, siendo el anterior el más señalado. En las restantes vueltas de la teleoconcha hay tres cordones espirales primarios. Los cordones formen espinas tubulares sobre las várices, abiertas en su parte anterior. La superficie de la concha está cubierta por finas laminillas de crecimiento, casi microscópicas, con el borde libre ondulado. Estas laminillas están más señaladas entre los cordones espirales. La abertura es aporcelanada, oval y pequeña, con cinco dentículos en el interior del labio palatal; uno superior; otra medio, grande y ancho, posiblemente formado por la fusión de dos dientes; y tres inferiores. Callo labial de borde libre en su porción columelar, en la que hay tres pliegues denticuliformes, de los que el superior en el más señalado. Canal sifonal abierto, moderadamente extendido.

"El color de fondo es blanco amarillento. En la última vuelta hay una banda pardo rojiza sobre el tercer cordón (de la sutura a la base) espiral primario. Esta banda oscura señala la línea de unión de las restantes vueltas. En la base de la concha hay otra banda del mismo color, pero más pálido." (Espinosa, 1990)

Holotype: Coleccion Malacólogica, Instituto de Ecología y Sistemática, Academia de Cíencias de Cuba, no. 70; height 7.2 mm, diameter 4.3 mm.

Type locality: Playa Rancho Luna, Cienfuegos, Cuba; sand bottom with coral reefs, between 8 and 20 meters.

Occurrence: Recent only, known only from type locality.

Figured specimen: USNM 880037 (paratype); height 7.5 mm, diameter 4.7 mm; locality same as holotype.

Discussion: This recently described species is known only from the type lot collected at Cienfuegos, Cuba. The author, Jose Espinosa, kindly provided me with a paratype specimen, here figured. As he notes, this species differs from *P. germainae,* the most closely related species, by the greater number of whorls and fewer axial varices. Moreover, *P. germainae* has six denticles on both the inner and outer lips.

V. LOCALITY DATA

The following are Tulane University fossil locality numbers:

60. Jackson Bluff Fm., borrow pits at Jackson Bluff, Ochlockonee River (NW 1/4 Sec. 21, T1S, R4W), Leon Co., Florida.
68. Caloosachatchee Fm., North St. Petersburg, 70th Ave. at 9th St. N., Pinellas Co., Florida.
78. Gosport Sand, Claiborne Bluff, east bank of Alabama River, south of bridge of U.S. Highway 84, Monroe Co., Alabama.
79. Caloosahatchee Fm. and Bermont Fm. mixed, spoil banks north and south side of Caloosahatchee River, at Ortona Lock (Sec. 27, T42S, R30E), Glades Co., Florida.
87. "Bashi" Fm., "Bashi boulders," west side of Pickett Creek on Alabama Highway 10, east edge of Butler, Choctaw Co., Alabama.
200. Pinecrest Beds, borrow pits about 1 mile southwest of Acline (Sec. 29, T41S, R23E), Charlotte Co., Florida.
201. Bermont Fm., spoil banks at pit just south of Belle Glade (at Belle Glade Camp), Palm Beach Co., Florida.
202. Caloosahatchee Fm., south bank of Caloosahatchee River, about 2 miles west of LaBelle (SE 1/4 Sec. 12, T43S, R28E), Hendry Co., Florida.
203. Caloosahatchee Fm., north bank of Caloosahatchee River, about 2 miles east of Fort Denaud (SW 1/4 Sec. 11, T43S, R28E), Hendry Co., Florida.
226. Red Bluff Fm., west bank Chickasawhay River, approximately 1 mile southwest of Hiwannee (SW 1/4 Sec. 28, T10N, R7W), Wayne Co., Mississippi.
457. Chipola Fm., west bank of Chipola River, about 1/2 mile below Tenmile Creek (SW 1/4 Sec. 17, T1N, R9W), Calhoun Co., Florida. (Same as USGS 2213, 2564, and 3419, "one mile below Bailey's ferry.")
458. Chipola Fm., east bank of Chipola River, above Farley Creek (SW 1/4 Sec. 20, T1N, R9W), Calhoun Co., Florida.
459. Chipola Fm., east bank of Chipola River, steep bank about 1500 feet above the mouth of Taylor Lake Branch (NW 1/4 Sec. 29, T1N, R9W), Calhoun Co., Florida.
519. Caloosahatchee Fm., Harney Pond Canal spoil banks, at Florida Highway 78, northwest side of Lake Okeechobee (NW 1/4 Sec. 18, T40S, R33E), Glades Co., Florida.
520. Pinecrest Beds, spoil banks, canal 0.9 mile east of Brighton on Florida Highway 70 (Sec. 25, T37S, R32E), Highlands Co., Florida.
523. Pinecrest Beds, Harney Pond Canal spoil banks, 6 miles northwest of Florida Highway 78, Brighton Indian Reservation (NW 1/4 Sec. 22, T39S, R32E), Glades Co., Florida.
525. Pinecrest Beds, U.S. Highway 41, at "Forty mile Bend," Dade Co., Florida.
527. Caloosahatchee Fm., north shore Lake Okeechobee, Pumping Station no. 127 (NE 1/4 Sec. 35, T39S, R33E), Glades Co., Florida.
528. Pinecrest Beds, Florida Highway 78, 5 1/2 miles west of Indian Prairie Canal (NW 1/4 Sec. 9, T40S, R33E), Glades Co., Florida.

529A. Fort Thompson Fm., north bank of Caloosahatchee River, about 2 miles west of La Belle (SE 1/4 Sec. 12, T43S, R28E), Hendry Co., Florida.

529B. Caloosahatchee Fm., same as TU 529A, but stratigraphically lower.

536. Caloosahatchee Fm., south bank of Caloosahatchee River about 1 mile east of La Belle (Sec. 3 & 4, T43S, R29E), Hendry Co., Florida. (Designated as type locality of the Caloosahatchee Formation by Olsson *in* Olsson and Petit, 1964, p. 529.)

539A. Bermont Fm., Shell Creek (upper beds), about 8 miles east of Cleveland (Sec. 30, T40S, R25E), Charlotte Co., Florida. (Designated as type locality of the Bermont Formation by DuBar, 1974, p. 221.)

539B. Caloosahatchee Fm., Shell Creek (lower beds), about 8 miles east of Cleveland (Sec. 30, T40S, R52E), Charlotte Co., Florida.

541. Pinecrest Beds and Caloosahatchee Fm. mixed, Miami Canal spoil banks, 2 miles north of pumping station at Broward county line, Palm Beach Co., Florida.

546. Chipola Fm., Tenmile Creek, about 1 3/4 miles west of Chipola River (NE 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida (= USGS 2212, "one mile west of Bailey's Ferry").

547. Chipola Fm., west bank of Chipola River, about 2000 ft. above Fourmile Creek (SW 1/4 Sec. 29, T1N, R9W), Calhoun Co., Florida.

548. Chipola Fm., west bank of Chipola River, at bend about 1800 feet south of mouth of Farley Creek (NW 1/4 Sec. 29, T1N, R9W), Calhoun Co., Florida.

554. Chipola Fm., east bank of Chipola River at power line crossing (SW 1/4 Sec. 17, T1N, R9W), Calhoun Co., Florida.

555. Chipola Fm., east bank of Chipola River, about 1000 ft. above Fourmile Creek (SW 1/4 Sec. 29, T1N, R9W), Calhoun Co., Florida.

558. Waccamaw Fm., borrow pits at north end of Crescent Beach Airport, Crescent Beach, Horry Co., South Carolina.

579. Caloosahatchee Fm., Miami Canal spoil banks, 4 miles north of pumping station at Broward county line, Palm Beach Co., Florida.

580. Bermont Fm., North New River Canal spoil banks, 1 mile south of South Bay, Palm Beach Co., Florida.

583. Caloosahatchee Fm., Miami Canal spoil banks, 7 miles north of pumping station at Broward county line, Palm Beach Co., Florida.

638. Agueguexquite Fm., roadcut, pipeline cut, and quarry on Mexico Highway 180, 14 miles east of junction with side road into Coatzacoalcos, Veracruz, Mexico.

642. Red Bluff Fm., Chickasawhay River at Hiwannee (NE 1/4 Sec. 28, T10N, R7W), Wayne Co., Mississippi.

725. Bermont Fm., North New River Canal spoil banks, 3 miles south of South Bay, at Okeelanta, Palm Beach Co., Florida.

726. Caloosahatchee Fm., Hendry County rock pit, 1/2 mile north of Florida Highway 80, three miles west of La Belle (SE 1/4 Sec. 14, T43S, R28E), Hendry Co., Florida.

727. Bermont Fm., borrow pits 2.2 miles east of U.S. Highway 27, 15 miles south of South Bay, Palm Beach Co., Florida.

728. Pinecrest Beds, spoil banks on west side of Kissimmee Canal and east side of Kissimmee River, just across from U.S. Corps of Engineers Structure 65-D (Sec. 33, T36S, R33E), Okeechobee Co., Florida.

729. Pinecrest Beds, spoil banks on west side of Kissimmee Canal and east side of Kissimmee River, approximately 1/2 mile south of U.S. Corps of Engineers Structure 65-D (S 1/2 Sec. 33, T36S, R33E), Okeechobee Co., Florida.

730. Pinecrest Beds, embankment of Seaboard Airline Railroad, just west of Kissimmee River, (NW 1/4 Sec. 20, T36S, R33E), Highlands Co., Florida.

736. Pinecrest Beds and Caloosahatchee Fm. mixed, spoil banks on south side of Florida Highway 70 and east side of Kissimmee River, Okeechobee Co., Florida.

745. Caloosahatchee Fm., Miami Canal spoil banks, 10.8 miles north of pumping station at Broward county line, Palm Beach Co., Florida.

751. Bermont Fm., North New River Canal spoil banks, 1 1/2 miles south of South Bay, Palm Beach Co., Florida.

753. Pinecrest Beds, spoil banks on south side of Canal 41-C, 5.8 miles east of Brighton (SE 1/4 Sec. 35, T37S, R33E), Highlands Co., Florida.

755. Caloosahatchee Fm., Miami Canal spoil banks, 17.4 miles north of pumping station at Broward county line, Palm Beach Co., Florida.

756. Pinecrest Beds, Port Charlotte Development, spoil banks west side of Elkcan Waterway, 2.3 miles southeast of Port Charlotte Railroad Station (formerly Murdock) and 1.7 miles east of U.S. Highway 41 (Sec. 10, T40S, R22E), Charlotte Co., Florida.

759. Bermont Fm., spoil banks north side of Caloosahatchee River, 2 miles west of Ortona Lock (NE 1/4 Sec. 29, T42S, R30E), Glades Co., Florida.

767. Caloosahatchee Fm. and Bermont Fm. mixed, spoil banks north side of Caloosahatchee River, 5 miles west of Ortona Lock (NW 1/4 Sec. 36, T42S, R29E), Glades Co., Florida.

768. Caloosahatchee Fm. and Bermont Fm. mixed, spoil banks north side of Caloosahatchee River, 5 1/2 miles west of Ortona Lock (NW 1/4 Sec. 35, T42S, R29E), Glades

Co., Florida.

769. Pinecrest Beds, spoil banks east side of Kissimmee River, 1 1/2 to 2 miles south of U.S. Corps of Engineers Structure 65-D (NE 1/4 Sec. 35, T36S, R33E), Okeechobee Co., Florida.

770. Pinecrest Beds and Caloosahatchee Fm. mixed, spoil banks west side of Kissimmee River, 1 1/2 to 3 1/2 miles north of Florida Highway 70 (Secs. 10, 14, 15, and 28, T37S, R33E), Highlands Co., Florida.

791. Bermont Fm., spoil banks, Florida Cross State Barge Canal, 1 1/2 miles west of U.S. Highway 19 at Inglis, Citrus Co., Florida.

796. Pinecrest Beds, material exposed during construction of "Alligator Alley," 12.8 miles east of Florida Highway 29 (T49S, R32E), Collier Co., Florida.

797. Pinecrest Beds, material exposed during construction of "Alligator Alley", 13.3 miles east of Florida Highway 29 (T49S, R32E), Collier Co., Florida.

803. Bermont Fm., spoil banks south side of Caloosahatchee River, 2 miles west of Ortona Lock (NE 1/4 Sec. 29, T42S, R 30E), Glades Co., Florida.

816. Caloosahatchee Fm. and Bermont Fm. mixed, borrow pits, Cecil M. Webb Wildlife Management Area, 1.8 miles east of U.S. Highway 41 and 7.2 miles north of the Lee county line, Charlotte Co., Florida.

818. Chipola Fm., Farley Creek, 0.1 mile west of bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.

819. Chipola Fm., Farley Creek, 0.2 mile west of bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida).

820. Chipola Fm., Farley Creek, at bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.

821. Chipola Fm., Farley Creek, 0.1 mile east of bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.

822. Chipola Fm., Farley Creek, 1/4 mile east of bridge on Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.

823. Chipola Fm., Farley Creek,about 2000 feet east of bridge of Florida Highway 275 (SE 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.

824. Chipola Fm., Farley Creek, about 1/2 mile east of bridge of Florida Highway 275 (SE 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.

825. Chipola Fm., Farley Creek at abandoned mill about 1/4 mile west of bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.

826. Chipola Fm., Farley Creek, about 0.1 mile west of abandonedmill, which is 1/4 mile west of bridge of Florida Highway 275 (on section line between Sec. 20 & 21, T1N, R9W), Calhoun Co., Florida.

827. Chipola Fm.,Farley Creek, about 1/2 mile west of bridge of Florida Highway 275 (SE 1/4 Sec. 20, T1N, R9W), Calhoun Co., Florida.

830. Chipola Fm., Tenmile Creek, at power line crossing about 1 mile west of Chipola River (SE 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida.

870. Waccamaw Fm., pits on east side of North Carolina Highway 130, 2.8 miles north of Old Dock School, Old Dock, Columbus Co., North Carolina.

933. Pinecrest Beds, material exposed during construction of "Alligator Alley," 21.5 miles east of Florida Highway 29, Collier Co., Florida.

939. Caloosahatchee Fm. and Bermont Fm. mixed, south side of Caloosahatchee River, 5.2 miles west of Ortona Lock (NW 1/4 Sec 36, T42S, R29E), Glades Co., Florida.

950. Chipola Fm., Chipola River, west bank about 2000 feet above Farley Creek (SW 1/4 Sec. 20, T1N, R9W), Calhoun Co., Florida.

951. Chipola Fm., Tenmile Creek, about 1 1/4 miles west of Chipola River (SE 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida.

953. Moín Fm., type locality, Moín Hill, railroad cut and adjacent ditches on road to Sandoval 4.5 km west of Puerto Limón, Costa Rica.

954. Moín Fm., hill cutimmediately behind Standard Fruit Co., box factory, just west of cemetery at Pueblo Nuevo, about 2 km west of Puerto Limón, Costa Rica.

974. Caloosahatchee Fm. and Bermont Fm. mixed, northside Caloosahatchee River, 2 1/2 to 3 1/2 miles west of center of former Lake Hicpochee (now drained) (unmapped area, T42S, R32E), Glades Co., Florida.

975. Caloosahatchee Fm., spoil banks north side Caloosahatchee River, 0 to 1/2 mile west of center of former Lake Hicpochee (now drained) (unmapped area, T42S, R32E), Glades Co., Florida.

977. Unnamed post-Pleistocene formation, mudlump no. 90, mouth of South Pass, Mississippi River delta, Plaquemines Parish, Louisiana.

978. Bermont Fm., spoil banks at pit on south side of waterworks, about 1 1/2 miles northeast of South Bay, Palm Beach Co., Florida.

982. Pinecrest Beds, Port Charlotte Development, spoil banks on northwest side of Florida Highway 771, on canal 3 1/2 miles southwest of junction with U.S. Highway 41 (Sec. 15, T40S, R21E), Cahrlotte Co., Florida.

987. Bermont Fm., spoil banks south side West Plam Beach Canal, at Loxahatchee, on U.S. Highway 98, Palm Beach Co., Florida.

988. Bermont Fm., spoil banks, West Palm Beach Canal at Twenty Mile Bend Recreation area, about 1 mile east of junction of U.S. Highways 98 and 441, Palm Beach Co., Florida.

991. Caloosahatchee Fm., Cochran rock pit, 2 1/2 miles west of La Belle, on north side of Florida Highway 80, Hendry Co., Florida.
998. Chipola Fm., Tenmile Creek, about 1 1/4 miles west of Chipola River (SE 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida.
999. Chipola Fm., Farley Creek, about 300 yards downstream from bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.
1000. Pinecrest Beds, APAC pits at east end of 17th street (T36S, R19E), about 8 miles east of U.S. Highway 301 at Sarasota [now northwest corner of Fruitville Road exit I-75], Sarasota Co., Florida.
1023. Caloosahatchee Fm. and Bermont Fm. mixed, pits on U.S. Highway 441, at intersection of Florida Highway 717, about 1 mile east of Pahokee, Palm Beach Co., Florida.
1044. Pinecrest Beds, spoil banks, west side of L-28 Interceptor Canal, 3 1/2 miles north of junction with Hendry County Highway 833, north side of Big Cypress Indian Reservation (T47S, R33E), Hendry Co., Florida.
1046. Agueguexquite Fm., roadcuts on both sides of Mexico Highway 180, 7.5 miles (12 km) east of junction with side road into Coatzacoalcos, Veracruz, Mexico. (This locality is that described in Perrilliat Montoya, 1960, p. 5).
1048. Chipola Fm., Farley Creek, about 0.8 mile east of bridge of Florida Highway 275 (NE 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.
1049. Farley Creek, about 1.0 mile east of bridge on Florida Highway 275 (NE 1/4 Sec 21, T1N, R9W), Calhoun Co., Florida.
1174. Caloosahatchee Fm., spoil banks along canals north of Florida Highway 858, 1.3 miles east of junction with Florida Highway 846 (SE 1/4 Sec. 13, T48S, R27E), east of Naples and south of Immokalee, Collier Co., Florida.
1175. Pinecrest Beds and Caloosahatchee Fm. mixed, spoil banks along canals south of Florida Highway 858, 2.0 miles east of junction with Florida Highway 846 (SE 1/4 Sec. 24, T48S, R27E), east of Naples and south of Immokalee, Collier Co., Florida.
1177. Pinecrest Beds and CaloosahatcheeFm. mixed, Mule Pen Quarry, north side of Florida Highway 846, 9.1 miles east of U.S. 41 at Naples Park (SE 1/4 Sec. 24, T48S, R26E), Collier Co., Florida.
1196. Chipola Fm., Farley Creek, about 0.8 mile east of bridge on Florida Highway 275 (NE 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.
1210. Gurabo Fm., Río Gurabo, east bank, first bluff downstream from ford on Los Quemados-Sabaneta road, Dominican Republic.
1211. Gurabo Fm., Río Gurabo, west bank, second bluff below the ford on Los Quemados-Sabaneta road, Dominican Republic.
1215. Gurabo Fm., Río Gurabo, bluffs on both sides, from the ford on Los Quemados-Sabaneta road, upstream to approximately 1 km above the ford, Dominican Republic.
1219. Gurabo Fm., Río Amina, bluffs on east side of river immediately upstream from ford that is 2 km west of Potrero and about 3 km downstream from "La Represa," Dominican Republic.
1227. Gurabo Fm., Arroyo Zalaya, which crosses road to Jánico from Santiago de los Caballeros, 11 km south of bridge over Río Yaque del Norte at Santiago, Dominican Republic.
1227A. Gurabo Fm., Arroyo Zalaya, turbidity flow lens (ca. 30" long, 6" thick) about two feet above base of outcrop, at point approximately 75 feet downstream from highway bridge, Dominican Republic.
1230. Cercado Fm.,Río Cana, east bank, just above the bridge at Caimito on Los Quemados-Sabaneta road, Dominican Republic.
1239. Moín Fm., hill cut above Standard Fruit Co., box factory at Pueblo Nuevo (same as TU 954 but stratigraphically about 50 ft. higher – above coral horizon), Puerto Limón, Costa Rica.
1240. Moín Fm., Barrio Los Corales, top of hill at end of road that passes Standard Fruit Co., box factory (see TU 954), 1.8 km north of main highway at Pueblo Nuevo, which is 2 km west of Puerto Limón, Costa Rica.
1249. Unnamed formation, roadcut 8.6 km west of the plaza at San Cristobal, on road to Bani, Dominican Republic (= loc. H-20001, Bermudez, 1949).
1250. Gurabo Fm., Río Verde, south bank, just above the ford at the crossing of a side road that connects Duarte Highway and La Vega-Moca Highway, about 10 km north of La Vega, Dominican Republic.
1269. Cantaure Fm., series of arroyos about 500 meters south of "Casa Cantaure". [which is literally one house and which is about 400 meters south of older, now abandoned, house that was the "Casa Cantaure" of Jung, 1965, and others], 14 km (by road) west of Pueblo Nuevo, Paraguana Peninsula, Venezuela.
1277. Gurabo Fm., Río Gurabo, both sides, upstream from the horsetrail to 0.5 km above the trail, or approximately 2 km (airline) to 2.5 km above the bridge on Los Quemados-Sabaneta road, Dominican Republic.
1288. Red Bluff Fm., type locality, east bank Chickasawhay River, about 1 1/2 miles south of Shubuta (NE 1/4 Sec. 16, T10N R7W),

Wayne Co., Mississippi.

1292. Gurabo Fm., Rio Mao, west bank, bluffs about 1.5 to 2 km upstream from Mao Adentro, or about 9 km (by road) south of Mao, Dominican Republic.

1296. Gurabo Fm., Río Gurabo, both sides, from about 0.5 km above the horsetrail to approximately 1 km above the trail, or about 2.5 to 3 km (airline) above the ford on Los Quemados-Sabaneta road, Dominican Republic.

1307. Moín Fm., hill top approximately halfway between Puerto Limón and Barrio Los Corales and about 0.5 km north of highway at Pueblo Nuevo, Costa Rica.

1323. (?) Medias Aguas Fm., Istal (formerly Santa Rosa), town on side road that was old railroad right-of-way, 6 miles west of Mexico Highway 185, at a point 10 miles north of side road to Jesus Carranza, Veracruz, Mexico.

1324. (?) Medias Aguas Fm., road to Istal (formerly Santa Road), road is old railroad right-of-way, 3 miles west of Mexico Highway 185, at a point 10 miles north of side road to Jesus Carranza, Veracruz, Mexico.

1358. Cercado Fm., Río Gurabo, west side at and downstream from mouth of Arroyo La Cabra, approximately 6 km (airline) above the ford on Los Quemados-Sabaneta road, Dominican Republic.

1364. Baitoa Fm., Boca de los Ríos, below the waterfall in Arroyo Hondo, which enters Río Yaque del Norte from the east, just below the confluence with Río Bao, downstream from Baitoa, Dominican Republic.

1412. Gurabo Fm., Río Guanajuma, which is a tributary of Río Amina from the west, bluff on south side, just upstream from trail at Higuerito Penuelas, which goes to the river approximately 2.5 km upstream from the confluence with Río Amina; or about 1 km above the ford on the road to Potrero, Dominican Republic.

1422. Cercado Fm., Arroyo Bellaco (or Beyaco on topographic maps), which is a tributary of Río Cana from the east, coral reef that is exposed for approximately 1 km below the ford at Las Caobas Adentro, 1 km southwest of Las Caobas, Dominican Republic.

1453. Gurabo Fm., Arroyo Zalaya, from above the waterfall (which is aproximately 1 km above the bridge on road from Jánico to Santiago de los Caballeros, 11 km south of bridge over Río Yaque del Norte at Santiago) to the headwaters, Dominican Republic.

1453A. Gurabo Fm., Arroyo Zalaya, shallow-water gravity flows into the deep-water beds, one just above waterfall, and another about 0.5 km upstream from waterfall, Dominican Republic.

1489. Moín Fm., Barrio Los Corales no. 3, about 0.4 km north of TU 1240, Puerto Limón, Costa Rica.

1490. Moin Fm., Barrio Los Corales no. 3, about 0.4 km east of TU 1240, Puerto Limón, Costa Rica.

1491. Pinecrest Beds, North Ft. Myers, pits open during construction of Cape Coral, northwest of intersection of U.S. Highway 41 and Florida Highway 78, Lee Co., Florida.

1493. Pinecrest Beds, Arvida Pit, on Bird Road(= W. 40th St.), approximately 5 miles west of Florida Turnpike, on west side of Coral Gables, Dade Co., Florida.

1512. Caloosahatchee Fm. and Bermont Fm. mixed, DeSoto Shell Company, pits 2 miles east of Florida Highway 31, about 12 miles south of Arcadia (T39S, R25E), DeSoto Co., Florida.

1524. Pinecrest Beds, Quality Aggregate Pit, off Richardson Road, north side of Fruitville Road and east of highway I-75, east of Sarasota, Sarasota Co., Florida.

1536. Pinecrest Beds, Caloosahatchee Fm. and Bermont Fm. mixed, Star Ranch, Bergeron Rock Co. pit, 11.4 miles south of South Bay, and 0.8 mile west of U.S. Highway 27, Palm Beach Co., Florida.

The following are Tulane University Recent locality numbers:

R-42. Anna Maria Key, off Sarasota, Florida; dredged in approximately 46 meters by James Moore, Bradenton, Florida.

R-99 *Anton Bruun* Curise 10, dredged in 31 meters, off northeastern Yucatan Peninsula (21° 41' N, 86° 34' W), Mexico.

R-109. Bahia de las Minas, Isla Payardi, Prov. of Colon, Panama (7000 YBP).

R-188. Venado Island, just east of Canal Zone-Panama boundary line, Canal Zone (Pacific side).

R-318. Buck Island, beach at south point of island, off northeast end of St. Croix, U.S. Virgin Islands.

R-326. Beach at Caribe Playa Hotel, about 12 miles east of Guayama, Puerto Rico.

R-360. Beach at Nagua, northeastern Dominican Republic.

R-366. Punta Cahuita, 42 km southeast of Puerto Limon, Costa Rica.

R-389. Monte Cristi, beach at foot of mountain, at north side of town, Dominican Republic.

R-423. Playa Las Salinas, at Pta. Caballera, mouth of Bahia de las Calderas, west of Bani, Dominican Republic.

The following are Naturhistorisches Museum, Basel Switzerland, fossil locality numbers:

16842. Cercado Fm., Río Cana, approximately 2.5 km below the bridge at Caimito, Los

Quemados-Sabaneta road, Dominican Republic.
16943. Baitoa Fm., Río Yaque del Norte, just downstream from Boca de los Rios, Dominican Republic.
17515. Cantaure Fm., Casa Cantaure, Paraguana Peninsula, Edo. de Falcón, Venezuela [= locality TU 1269].
17516. Cantaure Fm., Casa Cantaure, Paraguana Peninsula, Edo. de Falcón, Venezuela [= locality TU 1269].
17530. Mataruca Member, Caujarao Fm., Cementerio de Carrizal, Edo. de Falcón, Venezuela.
17531. Punta Gavilán Fm., type locality, Punta Gavilán, Edo. de Falcón, Venezuela.

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POSTSCRIPT

The gender of the word "*Haustellum*" was not a problem so long as the taxon was treated as a subgenus of the masculine genus *Murex*. But with elevation to full generic rank the question arose and it was concluded (Vokes, 1993, p. 12*) that *Haustellum* is a neuter noun. Thus, several species names in the western Atlantic fauna should be modified to agree. These are: *adelosum, blakeanum, messorium, polynematicum,* and *rubidum*. The name *chrysostoma* is a noun and all other valid names are either patronymics or geographic terms, which do not change.

*VOKES, E.H., 1993, Taxonomic note on the genus *Haustellum* (Gastropoda:Muricidae): Amer. Conchologist, v. 21, no. 4, p. 12.

VII. APPENDIX I: ALPHABETICAL LIST OF SPECIES INCLUDED IN THIS PART

The following list includes all species treated systematically and is a complete list of names for all western Atlantic species, fossil and Recent, valid or invalid, referred to the subfamily Muricopsinae.

The original genus in which the species was named is given in brackets following the name. Those species names in ALL CAPS are new taxa described herein. The generic assignment that follows the name of the author is that one to which the species is referred in this paper. Those names without a generic assignment are considered synonyms of the species cited.

aliceae [Muricopsis] Petuch, 1987. FAVARTIA (PYGMAEPTERYS)

alta [Ocinebra] Dall, 1890. = *cellulosa*

alveatus [Murex] Kiener, 1842. FAVARTIA (CARIBIELLA)

AMPHILOGOS [*Murexsul*] Vokes. MUREXSUL

ascensus [Calotrophon] Vokes, 1976. ACANTHOTROPHON

aspinosus [Murex] Meyer, 1886. MURICOPSIS (RISOMUREX)

BARBARAE [*Favartia*] Vokes. FAVARTIA s.s.

burnsi [Murex] Whitfield, 1894. = *faceta*

calhounensis [Murexiella] Vokes, 1968. HOMALOCANTHA

caribbaea [Tritonalia] Bartsch and Rehder, 1939. MURICOPSIS (RISOMUREX)

CARMENAE [*Favartia*] Vokes. FAVARTIA (CARIBIELLA)

cellulosa [Murex] Conrad, 1846. FAVARTIA s.s.

COMPTULUS [*Murexsul*] Vokes. MUREXSUL

conradi [Murex] d'Orbigny, 1850. = *mantelli*

crassicosta [Jania] Benoist, 1873. MURICOPSIS (RISOMUREX)

crispangula [Murex] Heilprin, 1886. HOMALOCANTHA

deformis [Ricinula] Reeve, 1846. MURICOPSIS (RISOMUREX)

drezi [?Pygmaepterys] Vokes and D'Attilio, 1980. FAVARTIA (PYGMAEPTERYS)

duffyi [Muricopsis] Petuch, 1992. = *huberti*

edwardpauli [Murexiella] Petuch, 1990. MUREXIELLA s.s.

elegans [Aspella] "Perrilliat Montoya" in Vokes, 1971. = *alveata*

emipowlusi [Ocenebra] Abbott, 1954. MUREXSUL

facetus [Murex] Vokes, 1963. MUREXIELLA s.s.

fasciatus [Murexiella] "Vokes" Sunderland and Sunderland, 1992. = *hilli*

galbensis [Risomurex] Jung, 1969. MURICOPSIS (RISOMUREX)

germainae [?Pygmaepterys] Vokes and D'Attilio, 1980. FAVARTIA (PYGMAEPTERYS)

gilbertharrisi [Drupa] Weisbord, 1962. MURICOPSIS (RISOMUREX)

glyptus [Murex] M. Smith, 1938. MUREXIELLA s.s.

graceae [Tritonalia] McGinty, 1940. MUREXIELLA s.s.
harasewychi [Murexsul] Petuch, 1987. MUREXSUL
hexagonus [Murex] Lamarck, 1816. = *oxytata*
hidalgoi [Murex] Crosse, 1869. MUREXIELLA s.s.
hilli [Murexiella] Petuch, 1987. MUREXIELLA s.s.
huberti [Muricopsis] Radwin and D'Attilio, 1976. MURICOPSIS s.s.
iemanja [Murexiella] Petuch, 1979. = *glypta*
intermedius [Murex] C.B. Adams, 1850. = *alveata*
jamaicensis [Murex] Sowerby, 1879. = *cellulosa*
JOSEI [*Muricopsis*] Vokes. MURICOPSIS s.s.
juanitae [Pygmaepterys] Gibson Smith and Gibson Smith, 1983. FAVARTIA (PYGMAEPTERYS)
kalafuti [Murexiella] Petuch, 1987. MUREXIELLA s.s.
larvaecosta [Murex] Heilprin, 1886. = *crispangula*
leonardhilli [Murexiella] Petuch, 1987. = *macgintyi*
levicula [Ocinebra] Dall, 1889. MUREXIELLA s.s.
lindae [Favartia] Petuch, 1987. FAVARTIA s.s.
lourdesae [Pygmaepterys] Gibson Smith and Gibson Smith, 1983. FAVARTIA (PYGMAEPTERYS)
lyonsi [Muricopsis] Petuch, 1986. = *oxytata*
macgintyi [Murex] M. Smith, 1938. MUREXIELLA s.s.
mantelli [Murex] Conrad, 1834. MUREXIELLA s.s.
MARCUSI [*Muricopsis*] Vokes. MURICOPSIS s.s.
micromeris [Murex] Dall, 1890. FAVARTIA s.s.
mimicus [Murexsul] Vokes, 1989. MUREXSUL
minirosea [Ocenebra] Abbott, 1954. FAVARTIA s.s.
mosquitensis [Risomurex] Kemperman and Coomans, 1984. = *deformis*
muricoides [Fusus] C.B. Adams, 1845. = *caribbaea*
NANISSIMUS [?*Murexsul*] Vokes. ?MUREXSUL
necocheanum [Sistrum, as *nicocheanum]* Pilsbry, 1900. MURICOPSIS (?RISOMUREX)
nuceus [Murex] Mörch, 1850. FAVARTIA s.s.
oxossi [Muricopsis] Petuch, 1979. FAVARTIA (PYGMAEPTERYS)
oxytata [Murex] M. Smith, 1938. MURICOPSIS s.s.
pacei [Favartia] Petuch, 1988. FAVARTIA s.s.
PARVULA [*Murexiella*] Vokes. MUREXIELLA s.s.
petiti [Murexiella] Vokes, 1968. MUREXIELLA s.s.
PETUCHI [*Murexiella*] Vokes. MUREXIELLA s.s.
PEREXIGUA [*Muricopsis*] Vokes. MURICOPSIS s.s.
praepauxillus [Murex] Maury, 1917. MURICOPSIS s.s.
pratulum [Pygmaepterys] Vokes and D'Attilio, 1980. FAVARTIA (PYGMAEPTERYS)
puntagordanum [Murex] Weisbord, 1962. MUREXIELLA s.s.
quisqueyensis [Muricopsis] Vokes, 1989. MURICOPSIS s.s.
rauli [Pygmaepteris] [sic] Espinosa, 1990. FAVARTIA (PYGMAEPTERYS)
richardbinghami [Muricopsis] Petuch, 1987. FAVARTIA (PYGMAEPTERYS)
rosea [Ricinula] Reeve, 1846. MURICOPSIS (RISOMUREX)
rubidum [Sistrum] Dall, 1889. = *deformis*
scabrosa [Tritonalia] Dall, 1915. MURICOPSIS s.s.
schrammi [Engina] Crosse, 1863. MURICOPSIS (RISOMUREX)
shilohensis [Murex] Heilprin, 1888. MUREXIELLA s.s.
SHIRLEYAE [*Muricopsis*] Vokes. MURICOPSIS s.s.
STEPHENSAE [*Murexiella*] Vokes. MUREXIELLA s.s.
striata [Muricidea] Gabb, 1873. ACANTHOTROPHON
striatoides [Acanthotrophon] Vokes, 1980. ACANTHOTROPHON
sunderlandi [Muricopsis] Petuch, 1987. MURICOPSIS s.s.
taylorae [Murexiella] Petuch, 1987. MUREXIELLA s.s
textilis [Murex] Gabb, 1873. MUREXIELLA (SUBPTERYNOTUS)
thalmanni [Hexaplex] Vokes, 1968. MUREXSUL
varimutabilis [Favartia] Houart, 1991. ?FAVARTIA s.s.
vaughani [Murexiella] MacNeil *in* MacNeil and Dockery, 1984. MUREXIELLA s.s.
veracruzana [Murexiella] Vokes, 1968. MUREXIELLA s.s.
warreni [Muricopsis] Petuch, 1993. MURICOPSIS s.s.
withrowi [Muricopsis] Vokes and Houart, 1986. MURICOPSIS (RISOMUREX)
zalaya [Favartia] Vokes, 1989. FAVARTIA s.s.
zylmanae [Muricopsis] Petuch, 1993. MURICOPSIS s.s.

VIII. APPENDIX I: STRATIGRAPHICAL LIST OF SPECIES INCLUDED IN THIS PART

The following list is arranged in approximately ascending stratigraphical order, with all of the species recognized as occurring in each formation.

EARLY EOCENE

Bashi Marl Member, Hatchitigbee Formation, Alabama
- *Murexsul* species

MIDDLE EOCENE

Gosport Sand, Alabama
- *Murexiella (Murexiella) mantelli*

EARLY AND MIDDLE OLIGOCENE

Red Bluff Formation, Mississippi
- *Muricopsis (Risomurex) aspinosa*
- *Murexiella (Murexiella) vaughani*

LATE OLIGOCENE/EARLY MIOCENE

Tampa Limestone, Florida
- *Muricopsis (Muricopsis) scabrosa*
- *Homalocantha crispangula*

EARLY MIOCENE

Kirkwood Formation, New Jersey
- *Murexiella (Murexiella) shilohensis*
- *Murexiella (Murexiella) faceta*

Chipola Formation, Florida
- *Muricopsis (Muricopsis) shirleyae*
- *Muricopsis (Muricopsis)* species
- *Muricopsis (Risomurex) crassicosta*
- *Murexsul nanissimus*
- *Murexiella (Murexiella) parvula*
- *Murexiella (Subpterynotus) textilis*
- *Homalocantha calhounensis*
- *Favartia (Pygmaepterys) drezi*
- *Favartia (Pygmaepterys) pratulum*

Baitoa Formation, Dominican Republic
- *Muricopsis (Muricopsis)* species
- *Murexiella (Subpterynotus) textilis*

Cantaure Formation, Venezuela
- *Muricopsis (Risomurex) crassicosta*
- *Murexiella (Subpterynotus) textilis*

MIDDLE MIOCENE

Unnamed formation, Dominican Republic
- *Homalocantha* species

Calvert Formation, Maryland
- *Murexiella (Murexiella) shilohensis*

LATE MIOCENE

(?)Medias Aguas Formation, Mexico
- *Murexiella (Murexiella)* species
- *Favartia (Caribiella) carmenae*

Boleo Formation, Baja California (Pacific coast)
- *Murexiella (Subpterynotus) textilis*

Cercado Formation, Dominican Republic
- *Muricopsis (Muricopsis) praepauxilla*
- *Murexiella (Murexiella) macgintyi*
- *Favartia (Favartia)* species
- *Favartia (Pygmaepterys) germainae*

Caujaro Formation, Venezuela
- *Murexiella (Subpterynotus) textilis*

PLIOCENE

Gurabo Formation, Dominican Republic
- *Muricopsis (Muricopsis) praepauxilla*
- *Muricopsis (Muricopsis) quisqueyensis*
- *Murexsul mimicus*
- *Acanthotrophon striatus*
- *Murexiella (Murexiella) hidalgoi*
- *Murexiella (Murexiella) macgintyi*
- *Favartia (Favartia)* species
- *Favartia (Favartia) zalaya*
- *Favartia (Pygmaepterys) germainae*

Esmeraldas Beds, Ecuador (Pacific coast)
- *Muricopsis (Muricopsis) oxytata*

Morne l'Enfer Formation, Trinidad
- *Muricopsis (Risomurex) galbensis*

Gatun Formation, Panama
- *Murexiella (Subpterynotus) textilis*

Agueguexguite Formation, Mexico
- *Muricopsis (Muricopsis)* sp. cf. *quiqueyensis*
- *Murexsul thalmanni*
- *Acathotrophon striatoides*
- *Murexiella (Murexiella) faceta*
- *Murexiella (Murexiella) veracruzana*
- *Murexiella (Murexiella) edwardpauli*

Punta Gavilán Formation, Venezuela
- *Murexiella (Murexiella) macgintyi*

Pinecrest Beds [= Fruitville Formation], Florida
- *Muricopsis (Muricopsis) oxytata*
- *Acanthotrophon striatoides*
- *Murexiella (Murexiella) shilohensis*
- *Murexiella (Murexiella) faceta*
- *Murexiella (Murexiella) hidalgoi*
- *Murexiella (Murexiella) petuchi*
- (?)*Murexiella (Murexiella) levicula*
- *Murexiella (Subpterynotus) textilis*
- *Favartia (Favartia) cellulosa*

Jackson Bluff Formation, Florida
- *Murexiella (Murexiella) shilohensis*
- *Murexiella (Murexiella) faceta*
- *Murexiella (Subpterynotus) textilis*

Tamiami Formation, Florida
- *Muricopsis (Muricopsis) oxytata*
- *Acanthotrophon striatoides*
- (?)*Murexiella (Murexiella) stephensae*
- *Murexiella (Subpterynotus) textilis*
- *Favartia (Favartia) cellulosa*

Duplin Formation, North Carolina
Murexiella (Murexiella) faceta
Favartia (Favartia) cellulosa

PLIO-PLEISTOCENE

Caloosahatchee Formation, Florida
Muricopsis (Muricopsis) oxytata
Acanthotrophon striatoides
Murexiella (Murexiella) shilohensis
Murexiella (Murexiella) macgintyi
Murexiella (Murexiella) glypta
(?)*Murexiella (Murexiella) edwardpauli*
Murexiella (Subpterynotus) textilis
Favartia (Favartia) micromeris
Favartia (Favartia) cellulosa

Tubará Group, Colombia
Muricopsis (Muricopsis) oyxtata

Mare Formation, Venezuela
Muricopsis (Risomurex) gilbertharrisi
Murexiella (Murexiella) puntagordanum

PLEISTOCENE

Waccamaw Formation, South Carolina
Murexsul comptulus
Murexiella (Murexiella) shilohensis
Murexiella (Murexiella) macgintyi
Murexiella (Murexiella) glypta
Murexiella (Murexiella) petiti
Favartia (Favartia) cellulosa

James City Formation, North Carolina
(?)*Murexiella (Murexiella) macgintyi*

Bermont Formation, Florida
Muricopsis (Muricopsis) oxytata
Acanthotrophon striatoides
(?)*Murexiella (Murexiella) macgintyi*
Murexiella (Murexiella) glypta
Murexiella (Murexiella) graceae
Favartia (Favartia) cellulosa
Favartia (Favartia) pacei
Favartia (Favartia) lindae

Moín Formation, Costa Rica
Muricopsis (Muricopsis) sp. cf. *quiqueyensis*
Muricopsis (Muricopsis) oxytata
Muricopsis (Risomurex) deformis
Murexsul harasewychi
Murexsul amphilogos
Acanthotrophon striatoides
Acanthotrophon ascensus
Murexiella (Murexiella) hidalgoi
Murexiella (Murexiella) glypta
Murexiella (Murexiella) edwardpauli
Favartia (Pygmaepterys) germainae

HOLOCENE

Unnamed formation, Louisiana
Murexsul emipowlusi
Murexiella (Murexiella) levicula
Favartia (Favartia) cellulosa

RECENT

Muricopsis (Muricopsis) oxytata, huberti, warreni, sunderlandi, zylmanae, perexigua, josei, marcusi
Muricopsis (Risomurex) gilbertharrisi, deformis, schrammi, rosea, caribbaea, withrowi, necocheana
Murexsul harasewychi, emipowlusi, species
Acanthotrophon striatoides, sp. cf. *ascensus*
Murexiella (Murexiella) hidalgoi, macgintyi, levicula, glypta, edwardpauli, puntagordanum, hilli, taylorae, kalafuti
Favartia (Favartia) cellulosa, pacei, minirosea, nuceus, lindae, barbarae, (?)*varimutabilis,* species
Favartia (Caribiella) alveata
Favartia (Pygmaepterys) germainae, oxossi, juanitae, lourdesae, richardbinghami, aliceae, rauli

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